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THE MOST SUITABLE PROPORTION BETWEEN THE VALUES OF FIRST AND SECOND PRIZES.

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A CERTAIN sum, say £100, is available for two prizes to be awarded at a forthcoming competition; the larger one for the first of the competitors, the smaller one for the second. How should the £100 be most suitably divided between the two? What ratio should a first prize bear to that of a second one? Does it depend on the number of the competitors, and if so, in what way? Similar questions may be asked, but will not be answered here, when the number of prizes exceeds two. What should be the division of the £100 when three prizes are to be given, or four, or any larger number?

The interest of this memoir does not depend solely upon the answer to the above questions, but more especially on its bringing to evidence a new property of the law of frequency of error, upon which I stumbled while engaged upon a side branch of the inquiry. The problem then before me (of which the results are still unpublished) was the probability that the winner of a first or of a second prize in a given year, would succeed in winning first or second prizes in subsequent years. The data assumed the following form:—100 winners of a first place supplied $m(1)$ winners of a first place, and $n(1)$ winners of a second place in subsequent years, while 100 winners of a second place supply $m(2)$ winners of a first place and $n(2)$ winners of a second place. What are the future prize-winning capacities of winners of first and second places respectively? Let the most appropriate values of first and second prizes be called α and β, then

$$\frac{\alpha}{\beta} = \frac{\alpha . m(1) + \beta . n(1)}{\alpha . m(2) + \beta . n(2)},$$

whence $\frac{\alpha}{\beta}$ can be determined.

Having found its value for the cases with which I was dealing, I sought to compare it with another obtained through the ordinary law of frequency of error, on the following bases:

(1) I concluded that when only two prizes α and β are given, their values should not be proportioned to the absolute merits of the two competitors, but to their respective *excesses* of merit above the third competitor, who receives no prize at all. Let $[A]$, $[B]$, and $[C]$ be the first, second, and third competitors, and a, b, c the marks allotted to them, then I conceive the most suitable relation of α to β is as $(a-c)$ to $(b-c)$, and not as a to b.

(2) If there be n competitors, considered as random samples from a large body among whom merit is normally distributed, the most reasonable presumption is that they will tend to occupy n equally probable positions. In the ordinary table of the Probability Integral the argument is $\pm hx$, whose values range from 0 to $\pm$ infinity, and the tabular values are those of $\Theta(hx)$ ranging from 0 to ± 1. For the present purposes $\Theta(hx)$ must be taken as the argument, running from -1, through 0, to $+1$, and hx becomes the tabular value. If there be n competitors the most equable, and therefore the most probable distribution of them along the scale of $\pm\Theta(hx)$, is that one competitor should fall into each of the n equidistant stalls ($\frac{1}{2}n$ stalls lying on either side of 0), the septa that enclose those stalls being situated at $0, +2, +4, \ldots +n$ on the positive side and at $0, -2, -4, \ldots -n$ on the negative side. I assume that each competitor fills his stall, and that his position is expressed with needful precision by the middle of the stall. Consequently the places of the several competitors will be taken to be at $+1, +3, +5, \ldots +(n-1)$ on the positive side and at $-1, -3, -5, \ldots -(n-1)$ on the negative side. Their position is purely a question of evenly distributed probabilities, entirely unconnected with the law by which the values of hx to which they refer are established. At the same time I am aware that others may hold that this method fails in accuracy, by treating the curve of distribution as a polygon, but I shall not stop to argue the point further because the difference of result is too small to weigh in the present argument. Following a nomenclature already adopted, in which the words 'centile' and 'decile' occur, I will call the n values in any array corresponding to those of $\Theta(hx) = \pm 1, \pm 3, \pm 5, \ldots \pm(n-1)$, by the name of "equi-postiles," and those of the septa between which they stand by that of "equi-partiles."

(3) Thus far it has been implied that the value of n is known, but, as a matter of fact, it seems usually impossible to arrive at even a grossly approximate idea of the number of *virtual* competitors; which far exceeds their *actual* number in all important competitions. The number of runners in the Derby are few, but they include the best horses out of a multitude of thoroughbreds, who are all qualified for entry but whose owners keep them back because their chance of winning was found by trial performances to be *nil*. The same happens in University scholarships, in the principal athletic sports, and in all competitions that arouse a widely felt and keen desire for distinction.

Therefore being ignorant of n, I selected a few widely different values of it for trial and worked out the $\Theta(hx)$ values of $[A]$, $[B]$, and $[C]$ by the formula

$\frac{1}{n}((n-1), (n-3), (n-5))$. Then I took from the Probability Integral Tables the corresponding values of hx.

As an example of the complete process let $n = 10$, then the most probable values of $\Theta(hx)$ for the ten competitors will, according to my assumption, be

$$-0{\cdot}9,\ -0{\cdot}7,\ -0{\cdot}5,\ -0{\cdot}3,\ -0{\cdot}1,\ +0{\cdot}1,\ +0{\cdot}3,\ +0{\cdot}5,\ +0{\cdot}7,\ +0{\cdot}9.$$

They are separated by equal distances from one another and by the half of those distances from the septa, including the terminals, that enclose them.

Confining ourselves to the first three terms on the positive side, that is to $+0{\cdot}9$, $+0{\cdot}7$ and $+0{\cdot}5$, we find from the Probability Integral Tables that the corresponding values of hx are $+1{\cdot}1631$, $+0{\cdot}7329$, $+0{\cdot}4770$.

The percentage values of $(a-c)$ and $(b-c)$ (as described above in (2)), are quickly derived from these. We will call them X and Y, and their sum S.

$ha = 1{\cdot}1631$	$h(a-c) = 0{\cdot}6861$
$hb = 0{\cdot}7329$	$h(b-c) = 0{\cdot}2559$
$hc = 0{\cdot}4770$	$hS \quad = 0{\cdot}9420$

$$X : 100 :: h(a-c) : hS; \quad Y : 100 :: h(b-c) : hS.$$

Whence $X = 72{\cdot}8$, $Y = 27{\cdot}2$.

Thus h disappears from the result while m, the Mean, does not come under consideration. If it had been taken into consideration by writing $m+a$ for a, $m+b$ for b, and $m+c$ for c, it would have been eliminated by the subtractions, as h was by the divisions.

Similarly if n be taken $= 1000$, the values of $\Theta(hx)$ for $[A]$, $[B]$, and $[C]$ would be $+0{\cdot}9990$, $+0{\cdot}9970$, and $+0{\cdot}9950$ which give $ha = +2{\cdot}3268$, $hb = +2{\cdot}0985$, and $hc = +1{\cdot}9849$.

Proceeding in this way for many widely different values of n, I found to my astonishment that the resultant X and Y values for those of $n = 10$ and above, came out curiously alike, as is shown in Table I.

TABLE I.

n	X	Y	$X+Y$
3	66·7	33·3	100·0
5	71·0	29·0	,,
10	72·8	27·2	,,
20	73·8	26·2	,,
50	74·3	25·7	,,
100	74·5	25·5	,,
1,000	75·1	24·9	,,
10,000	75·3	24·7	,,
100,000	75·4	24·6	,,

The values of X between those corresponding to $n = 50$ and $n = 100{,}000$ range within a difference of 1·1. The smallest possible class in which c is not negative, consists of five individuals, and even here the proportion of X to Y is as 71·0 to 29·0, which does not differ grossly from that in a class of 100,000 where it is 75·4 to 24·6. Nay, even taking the smallest possible class which is of three individuals, in which the values of ha, hb, hc are respectively equal to $-c$, 0, and $+c$, the value of $h(a-c) = 2hc$ and that of $h(b-c) = hc$. Consequently $S = 3hc$, therefore $X = 100 \times \frac{2}{3}$, and $Y = 100 \times \frac{1}{3}$, $= 66{\cdot}7$ and $33{\cdot}3$ as in the Table.

The rationale of the approximate uniformity of the value of X and Y seems well worthy of a more searching mathematical investigation than I am competent to make. It seems difficult to doubt that this curious property of the terminal equi-postiles is associated with others whose character cannot now be foreseen.

Comparison with facts. Many serious objections present themselves *à priori* to the useful application of this theory, among which is the partial non-conformity of examination marks with the law of frequency, especially at either end of the series, one of which is precisely the part here in question. I therefore put the theory to test by procuring through the kindness of friends a large number of sets of marks in various Civil Service examinations. I took them just as they came and found the X and Y values for each case, as in the following example.

No. 268.

$a = 1801$	$a - c = 130$
$b = 1712$	$b - c = 41$
$c = 1671$	$S = 171$

$X : 100 :: 130 : 171$; $Y : 100 :: 41 : 171$

$X = 78{\cdot}0$; $Y = 22{\cdot}0$; Total 100.

I grouped these values into fives, each page of my MS. book containing that number, then into twenty-fives, and so on. Individually their values ran very irregularly, but the groups of 25 began to give hopeful indications which were fully confirmed by larger groupings, as is shown in Table II. where the X values alone are entered. Those of Y are of course complementary to them.

Thus far the evidence that the calculation was correct in principle seemed conclusive, owing to its being so remarkably well confirmed by observation. In fact, I lived for a few days in a fool's paradise, thinking that such was the case, until with the desire of probing the matter more thoroughly, I made a Table of the distribution of the individual observations. The result is shown in Table III., which shattered my sanguine hopes. If the principle upon which the calculation is based had a contributory effect to any noticeable degree, in producing the mean value of 73·4 as shown in Table II., there would have been a concentration of values about that point in Table III. But there is nothing of the kind. The values are pretty equably distributed between 50 and 100, with a slight but

distinct tendency in the smaller values to be the more numerous. This seems due to the fact that the curve of distribution (*see Natural Inheritance*) is always convex towards its axis; consequently $b-c$ is on the average less than $\frac{1}{2}(a-c)$.

TABLE II.

Values of X derived from 300 *Lists of Marks in various Civil Service Examinations.*

Mean values of successive groups of		
25 cases	50 cases	100 cases
74·4	74·5	73·6
74·6		
70·6	72·6	
74·7		
75·7	73·3	72·9
70·9		
70·4	69·6	
68·8		
73·5	73·5	73·7
73·5		
74·7	73·9	
73·1		

Mean of all 300 cases, 73·4.

Subject to this qualification, the Mean is no more than the average of random values between certain limits. Those limits are created by the conditions (1) that b cannot exceed a though it may be equal to a, in which case one of the limits is $100(a-c)$ divided by $2(a-c)$, or 50; (2) that b cannot exceed c though it may be equal to c, in which case the other limit is $100(a-c)$ divided by $(a-c)+0$, or 100.

TABLE III.

Distribution of 300 *Observed Values of X.*

50—	*55—*	*60—*	*65—*	*70—*	*75—*	*80—*	*85—*	*90—*	*95—*	Total
40	36	27	31	32	23	34	30	26	21	300
76		58		55		64		47		300
166					134					300

Therefore it appears to be merely a coincidence that calculation and observation lead to much the same conclusion. The principle on which the former is based

is practically neutral in its effect on the observed results, neither contributing to nor conflicting with them in a sensible degree. The curious property of the foremost equi-postiles that it discloses, must rest its claims to interest upon its own merits and not upon any effective aid that it might be supposed to afford to solving the question of the most suitable proportion between the values of first and second prizes.

What I profess to have shown is

(1) that in the three topmost equi-postiles of a normal series, whose measures are a, b, and c, the value of $(a-c)$ is roughly three times as great as that of $(b-c)$, almost independently of the number of individuals in the series and quite independently of its Mean and of its Modulus of Variability.

(2) that observation leads to practically the same result as calculation, but almost wholly for a different reason.

(3) that when only two prizes are given in any competition, the first prize ought to be closely three times the value of the second.

I now commend the subject to mathematicians in the belief that those who are capable, which I am not, of treating it more thoroughly, may find that further investigations will repay trouble in unexpected directions.

Note on Francis Galton's Problem.

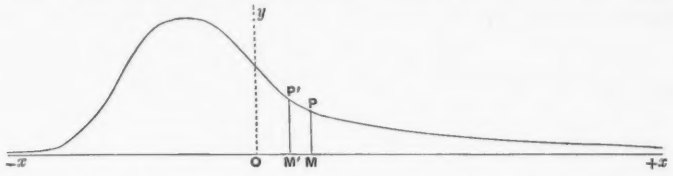
(1) THE problem proposed by Mr Galton is one of very great interest and, somewhat generalised, probably of wide application to a number of important biometrical investigations. In its generalised form it seems to open up possibilities of deducing statistical constants from comparatively small samples, for it provides us for the first time, I believe, with the most probable relationships between the individuals forming a random sample. I would state the problem as follows :

A random sample of n individuals is taken from a population of N members which when N is very large may be taken to obey any law of frequency expressed by the curve $y=N\phi(x)$, $y\delta x$ being the total frequency of individuals with characters or organs lying between x and $x+\delta x$. It is required to find an expression for the average difference in character between the p^{th} and the $(p+1)^{th}$ individuals when the sample is arranged in order of magnitude of the character.*

I propose to call this general problem : *Francis Galton's Individual Difference Problem in Statistics*, or more briefly *Galton's Difference Problem*. It will be seen at once to carry us from the consideration of the means and standard deviations of mass aggregates and arrays to the average interval between individuals of those aggregates. We may still deal with *averages*, but we fix our attention no longer on the whole population, but on definite individuals in its ordered array. This I believe to be a real advance in statistical theory.

* Clearly a knowledge of the average difference in character of adjacent individuals involves also a knowledge of the average difference in character between any two individuals.

(2) Let the figure represent any frequency distribution given by $y=N\phi(x)$, where we may suppose the limits, if finite, to be extended, if necessary, from $+\infty$ to $-\infty$ by zero ordinates. We make no hypothesis as to the nature of the distribution, or the position of the origin; as a



corollary we will deal with the case of normal distribution. Let N be the number of individuals or the area of the curve*, A the area to the left of any ordinate $PM=y$, at a character-value $OM=x$. Thus the area to the right is $N-A$. Then, if $a=A/N$, we shall have:

$$a=\int_{-\infty}^{+x}\phi(x)\,dx \quad \text{.....(i),}$$

an integral which may be supposed known when the distribution of the general population is known.

We first note that the chance of any random individual having a character less than x $=A/N=a$, and having a character greater than $x=(N-A)/N=1-a$. Now let $OM=x_p$ correspond to the p^{th} individual's character reckoned downwards and $OM'=x_{p+1}$, to the next or $(p+1)^{\text{th}}$ individual's character. Then we require first to find the mean value of $M'M=x_p-x_{p+1}$, there being $p-1$ individuals to right of PM and $n-p-1$ individuals to left of $P'M'$ in the sample of n individuals we are selecting out of the population. The chance of an individual falling at M is given by $y_p\delta x_p/N$, and of one at M' by $y_{p+1}\delta x_{p+1}/N$; the chance of an individual to left of $P'M'$ $=A_{p+1}/N$ and to right of PM $=(N-A_p)/N$. The total chance therefore of an individual at M, another at M' and $n-p-1$ to left of $P'M'$ and $p-1$ to right of PM

$$=\frac{y_p\delta x_p}{N}\times\frac{y_{p+1}\delta x_{p+1}}{N}\times\left(\frac{A_{p+1}}{N}\right)^{n-p-1}\times\left(\frac{N-A_p}{N}\right)^{p-1}.$$

But clearly we could permute the two individuals as well as those to right and left of PM and $P'M'$ and must introduce the factor $\lfloor n\,/\,(\lfloor n-p-1\ \lfloor p-1)$.† To get the average we must multiply the chance thus obtained by the corresponding x_p-x_{p+1} and first integrate from $x_{p+1}=-\infty$ to x_p and then for x_p from $-\infty$ to $+\infty$. For, the p^{th} and $(p+1)^{\text{th}}$ individuals may be anywhere in the range provided (i) there are no individuals between them, (ii) the $(p+1)^{\text{th}}$ is anywhere below the p^{th}, (iii) $p-1$ individuals fall above the latter, and (iv) $n-p-1$ individuals below the former. Hence if we write x' for x_{p+1}, x for x_p, a' for A_{p+1}/N, a for A_p/N, y_0' for y_{p+1}/N, y_0 for y_p/N, we have for χ_p the average interval between the p^{th} and $(p+1)^{\text{th}}$ individuals:

$$\chi_p=\frac{\lfloor n}{\lfloor n-p-1\ \lfloor p-1}\int_{-\infty}^{+\infty}dx\int_{-\infty}^{+x}dx'\,y_0/y_0'\,a'^{n-p-1}(1-a)^{p-1}(x-x') \quad \text{.....(ii),}$$

where by (i)

$$\frac{da'}{dx'}=y_0', \quad \frac{da}{dx}=y_0 \quad \text{.....(iii).}$$

* Since $\int_{-\infty}^{+\infty}y\,dx=N$, it follows that $\int_{-\infty}^{+\infty}\phi(x)\,dx=1$.

† We have to find the permutations of n things which may be distributed into four groups which contain respectively $p-1$, $n-p-1$, 1, and 1 individuals. This is the same as the number of ways in which out of n factors $(x+y+z+u)$ we can pick out $(p-1)$ x's, $(n-p-1)$ y's, one z and one u, i.e. the coefficient of $x^{p-1}y^{n-p-1}zu$ in $(x+y+z+u)^n$. But this coefficient is $\lfloor n\,/\,(\lfloor p-1\ \lfloor n-p-1\ \lfloor 1\ \lfloor 1)$. I owe this method of looking at the factor to Dr L. N. G. Filon.

Consider first the x' integral, i.e.

$$I=\int_{-\infty}^{+x} dx'\, y_0'\, a'^{n-p-1}(x-x')=\int_{-\infty}^{+x} da'\, a'^{n-p-1}(x-x'),$$

and integrate it by parts. It equals:

$$\left[\frac{a'^{n-p}}{n-p}(x-x')\right]_{-\infty}^{+x}+\int_{-\infty}^{+x}\frac{a'^{n-p}}{n-p}\,dx',$$

or between limits:

$$=\frac{1}{n-p}\int_{-\infty}^{+x} a'^{n-p}\,dx'=\frac{1}{n-p}\,U, \text{ say.}$$

Thus:

$$\chi_p=\frac{\lfloor n}{\lfloor n-p\ \lfloor p-1}\int_{-\infty}^{+\infty} y_0\, U(1-a)^{p-1}dx,$$

$$=\frac{\lfloor n}{\lfloor n-p\ \lfloor p-1}\int_{-\infty}^{+\infty} U(1-a)^{p-1}da, \text{ by (iii),}$$

$$=\frac{\lfloor n}{\lfloor n-p\ \lfloor p}\left\{\left[-U(1-a)^p\right]_{-\infty}^{+\infty}+\int_{-\infty}^{+\infty}\frac{dU}{dx}(1-a)^p dx\right\},$$

or, taking the value between limits and substituting $\frac{dU}{dx}$, we have

$$\chi_p=\frac{\lfloor n}{\lfloor n-p\ \lfloor p}\int_{-\infty}^{+\infty} a^{n-p}(1-a)^p\,dx \quad \text{.....(iv).}$$

This is the complete solution of Galton's difference problem*.

An interesting theorem which results from this has been given me by Mr W. F. Sheppard; namely: the average differences between successive individuals are the successive terms in

$$\int_{-\infty}^{+\infty}\{a+(1-a)\}^n\,dx$$

when the subject of integration is expanded by the binomial theorem.

Given any law of frequency $y_0=\phi(x)$, we must first find a from (i), and then when tables of a have been made, calculate χ_p by quadratures from (iv). This will be fairly easy, if the distribution be assumed to be normal, for then tables of a, or tables which readily give a, already exist, and quadratures may be used on (iv) to any degree of accuracy required. This has been done by Mr Sheppard in the cases cited below for comparison with Mr Galton's results.

It will be seen that the fundamental difference between the above theory and Mr Galton's lies in the assumption of the latter, that the individual results of a special examination give a sensibly normal distribution. The above theory only assumes that the competitors are a perfectly random sample from material which if it were indefinitely large would obey the law of frequency $y_0=\phi(x)$. Of course, if we want to compare with Mr Galton's results, we must assume this law to be the normal law, but we still have the great generalisation that the actual competitors are only a random sample from a great bulk of material following this law. In any individual examination, it may be quite possible—especially if the competitors are few—that the first man stands anywhere, even below mediocrity, and the chance of this is allowed for in this the full mathematical theory.

* This result is due independently to Mr W. F. Sheppard and myself. I had stated Mr Galton's problem to him, and said that I had reduced it to a determination of $\int_{-\infty}^{+\infty} A^r dx$. He sent me, practically by return of post, the answer in the above notation, suggesting quadratures as the best practical solution, and pointing out the theorem referred to in the text.

(3) Another method of reducing the integral in (iv) without quadratures is, perhaps, of interest. I have found it convenient in other cases, where the integral limits are, or can be safely extended to, $\pm\infty$. Suppose we require to find:

$$I=\int_{-\infty}^{+\infty} U\,dx.$$

Let m be the value of x for which U reaches the maximum value U_m and let $u=\log U$; thus $(du/dx)_m=0$, unless $U_m=\infty$. Then we find:

$$\begin{aligned}U=U_m e^{\frac{1}{2}\left(\frac{d^2u}{dx^2}\right)_m \xi^2}\Big\{&1+\tfrac{1}{6}\left(\frac{d^3u}{dx^3}\right)_m\xi^3+\tfrac{1}{24}\left(\frac{d^4u}{dx^4}\right)_m\xi^4\\&+\tfrac{1}{120}\left(\frac{d^5u}{dx^5}\right)_m\xi^5+\tfrac{1}{720}\left[\left(\frac{d^6u}{dx^6}\right)_m+10\left(\frac{d^3u}{dx^3}\right)^2_m\right]\xi^6\\&+\tfrac{1}{5040}\left[\left(\frac{d^7u}{dx^7}\right)_m+35\left(\frac{d^3u}{dx^3}\right)_m\left(\frac{d^4u}{dx^4}\right)_m\right]\xi^7\\&+\tfrac{1}{40320}\left[\left(\frac{d^8u}{dx^8}\right)_m+56\left(\frac{d^3u}{dx^3}\right)_m\left(\frac{d^5u}{dx^5}\right)_m+35\left(\frac{d^4u}{dx^4}\right)^2_m\right]\xi^8\\&+\text{terms in }\xi^9\text{ and higher powers}\Big\}\quad\text{.....(v).}\end{aligned}$$

Now since U is a maximum, d^2U/dx^2 and generally d^2u/dx^2 will be negative. The limits of ξ where $x=m+\xi$ will also be $\pm\infty$, and the integral of U can thus be expressed in terms of the well-known area and moments of the probability curve. In the first place, if $1/\sigma^2=-d^2u/dx^2$

$$\int_{-\infty}^{+\infty} e^{-\frac{1}{2}\xi^2/\sigma^2}\xi^{2i+1}d\xi=0$$

if i be an integer.

Further:

$$\int_{-\infty}^{+\infty} e^{-\frac{1}{2}\xi^2/\sigma^2}\xi^{2i}\,d\xi=(2i-1)(2i-3)\ldots\ldots3\,.\,1\sqrt{2\pi}\,\sigma^{2i+1}.$$

Hence writing $a_q=\left(\frac{d^qu}{dx^q}\right)_m$, we find:

$$I=\int_{-\infty}^{+\infty}U dx=U_m\sqrt{2\pi}\,\frac{1}{\sqrt{-a_2}}\left\{1+\frac{a_4}{8a_2^2}-\frac{a_6+10a_3^2}{48a_2^3}+\frac{a_8+56a_5a_3+35a_4^2}{384a_2^4}-\text{etc.}\right\}\text{.....(vi).}$$

The successive terms often converge with such rapidity that two or three of them are quite sufficient for practical purposes.

To apply this to our special case, we note

$$U=a^{n-p}(1-a)^p,$$

$$u=\log U=(n-p)\log a+p\log(1-a),$$

$$\frac{du}{dx}=\frac{1}{U}\frac{dU}{dx}=\left(\frac{n-p}{a}-\frac{p}{1-a}\right)\frac{da}{dx}.$$

Hence if U be a maximum, we have $du/dx=0$, and

$$a=(n-p)/n,\qquad 1-a=p/n\text{.....(vii).}$$

Thus m is to be found from

$$\frac{n-p}{n}=\int_{-\infty}^{m}y_0\,dx,$$

or, since

$$1=\int_{-\infty}^{+\infty} y_0\,dx,$$

$$\frac{p}{n}=\int_{m}^{\infty} y_0\,dx \qquad \text{(viii)}.$$

We find at once:

$$U_m=\frac{(n-p)^{n-p}\,p^p}{n^n} \qquad \text{(ix)}.$$

It remains to find the successive differentials of u for $x=m$. Let us write the value of y_0 at $x=m$, simply y_m, and we shall then have

$$(da/dx)_m=y_m, \quad d^2a/dx^2=y'_m, \quad d^3a/dx^3=y''_m, \text{ etc.}$$

We find:

$$a_2=-\frac{n^3}{(n-p)\,p}y^2{}_m$$

$$a_3=-\frac{2n^4(n-2p)}{(n-p)^2\,p^2}y^3{}_m-\frac{3n^3}{(n-p)\,p}y_m y'_m$$

$$a_4=-6n^4\left(\frac{1}{(n-p)^3}+\frac{1}{p^3}\right)y^4{}_m-\frac{12n^4(n-2p)}{(n-p)^2\,p^2}y^2{}_m y'_m-\frac{n^3}{(n-p)\,p}(3y'^2{}_m+4y_m y''_m)$$

$$a_5=-24n^5\left(\frac{1}{p^4}-\frac{1}{(n-p)^4}\right)y^5{}_m-60n^4\left(\frac{1}{(n-p)^3}+\frac{1}{p^3}\right)y^3{}_m y'_m$$
$$-10n^3\left(\frac{1}{p^2}-\frac{1}{(n-p)^2}\right)(3y_m y'^2{}_m+2y^2{}_m y''_m)$$
$$-5n^2\left(\frac{1}{p}+\frac{1}{n-p}\right)(2y'_m y''_m+y_m y'''_m)$$

$$a_6=-120n^6\left(\frac{1}{(n-p)^5}+\frac{1}{p^5}\right)y^6{}_m-360n^5\left(\frac{1}{p^4}-\frac{1}{(n-p)^4}\right)y^4{}_m y'_m$$
$$-30n^4\left(\frac{1}{(n-p)^3}+\frac{1}{p^3}\right)(9y^2{}_m y'^2{}_m+4y^3{}_m y''_m)$$
$$-30n^3\left(\frac{1}{p^2}-\frac{1}{(n-p)^2}\right)(y'^3{}_m+4y_m y'_m y''_m+y^2{}_m y'''_m)$$
$$-n^2\left(\frac{1}{n-p}+\frac{1}{p}\right)(10y''^2{}_m+15y'_m y'''_m+6y_m y^{iv}{}_m)$$
$$\text{etc. etc.} \qquad \text{(x)}.$$

These quantities may be calculated fairly easily when y is known as a function of x, the coefficients of the y terms in n and p repeating themselves in each a.

(4) Let us apply these results to the special case when the distribution from which the material is drawn is supposed to obey the normal law. In this case, if s be the standard deviation of the material from which the sample is made:

$$y=\frac{1}{\sqrt{2\pi}\,s}\,e^{-\frac{1}{2}x^2/s^2},$$

$$a=\int_{-\infty}^{+x} y\,dx,$$

$$\chi_p=c\times\int_{-\infty}^{+\infty} a^{n-p}(1-a)^p\,dx, \text{ if } c=\frac{\lfloor n}{\lfloor n-p\ \lfloor p}.$$

Write $x=sx'$, then, if $ys=y'$

$$y'=\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}x'^2},$$

$$a=\int_{-\infty}^{+x'}y'\,dx',$$

$$\chi_p=cs\int_{-\infty}^{+\infty}a^{n-p}(1-a)^p\,dx' \quad \text{.....(xi).}$$

Hence dropping dashes we have:

$$\frac{n-p}{n}=\int_{-\infty}^{+m}\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}x^2}dx,$$

or:

$$\frac{n-2p}{n}=\sqrt{\frac{2}{\pi}}\int_0^m e^{-\frac{1}{2}x^2}\,dx \quad \text{.....(xii).}$$

Thus as soon as n and p are known m can be found from tables of the probability integral. Then we may find y_m from

$$y_m=\frac{1}{\sqrt{2\pi}}e^{-\frac{1}{2}m^2} \quad \text{.....(xiii),}$$

or tables of the ordinates of the normal curve.

We easily find by differentiating (xiii) that:

$$y'_m=-my_m,\quad y''_m=(m^2-1)y_m,\quad y'''_m=m(3-m^2)y_m$$
$$y^{iv}{}_m=(3-6m^2+m^4)y_m,\quad y^{v}{}_m=m(10m^2-15-m^4)y_m \quad \text{.....(xiv).}$$

Substituting in (x) we find:

$$a_2=-n^2\left\{\frac{1}{n-p}+\frac{1}{p}\right\}y^2{}_m \quad \text{.....(xv).}$$

$$a_3=-2n^3\left\{\frac{1}{p^2}-\frac{1}{(n-p)^2}\right\}y^3{}_m+3n^2\left\{\frac{1}{n-p}+\frac{1}{p}\right\}my^2{}_m \quad \text{.....(xvi).}$$

$$a_4=-6n^4\left\{\frac{1}{p^3}+\frac{1}{(n-p)^3}\right\}y^4{}_m+12n^3\left\{\frac{1}{p^2}-\frac{1}{(n-p)^2}\right\}my^3{}_m$$
$$-n^2\left\{\frac{1}{n-p}+\frac{1}{p}\right\}(7m^2-4)y^2{}_m \quad \text{.....(xvii).}$$

$$a_5=-24n^5\left\{\frac{1}{p^4}-\frac{1}{(n-p)^4}\right\}y^5{}_m+60n^4\left\{\frac{1}{p^3}+\frac{1}{(n-p)^3}\right\}my^4{}_m$$
$$-10n^3\left\{\frac{1}{p^2}-\frac{1}{(n-p)^2}\right\}(5m^2-2)y^3{}_m+5n^2\left\{\frac{1}{p}+\frac{1}{n-p}\right\}m(3m^2-5)y^2{}_m \quad \text{...(xviii).}$$

$$a_6=-120n^6\left\{\frac{1}{p^5}+\frac{1}{(n-p)^5}\right\}y^6{}_m+360n^5\left\{\frac{1}{p^4}-\frac{1}{(n-p)^4}\right\}my^5{}_m$$
$$-30n^4\left\{\frac{1}{p^3}+\frac{1}{(n-p)^3}\right\}(13m^2-4)y^4{}_m+30n^3\left\{\frac{1}{p^2}-\frac{1}{(n-p)^2}\right\}m(6m^2-7)y^3{}_m$$
$$-n^2\left(\frac{1}{p}+\frac{1}{n-p}\right)(31m^4-101m^2+28)y^2{}_m \quad \text{.....(xix).}$$

If the a's be found from these equations, then by (xi) and (vi):

$$\chi_p=s\frac{\lfloor n}{\lfloor n-p\rfloor\lfloor p}\frac{(n-p)^{n-p}p^p}{n^n}\sqrt{2\pi}\sqrt{\frac{(n-p)p}{n^3}}\frac{1}{y_m}$$
$$\times\left\{1+\frac{a_4}{8a_2{}^2}-\frac{a_6+10a_3{}^2}{48a_2{}^3}+\text{etc.}\right\} \quad \text{.....(xx).}$$

Here the term in a_3^2 is generally the largest, a_4 the next and a_6 the least.

We can write the terms in the curled brackets:

$$c_1 = -\frac{10a_3^2}{48a_2^3} = \frac{5}{6}\frac{(n-2p)^2}{n(n-p)p} - \frac{5}{2}\frac{n-2p}{n^2}\frac{m}{y_m} + 1\frac{5}{8}\frac{(n-p)p}{n^3}\frac{m^2}{y^2_m} \quad \text{.....(xxii).}$$

$$c_2 = \frac{a_4}{8a_2^2} = -\frac{3}{4}\frac{(n-p)^3+p^3}{n^2(n-p)p} + \frac{3}{2}\frac{n-2p}{n^2}\frac{m}{y_m} - 1\frac{1}{8}\frac{(n-p)p}{n^3}\frac{7m^2-4}{y^2_m} \quad \text{.....(xxiii).}$$

$$c_3 = -\frac{a_6}{48a_2^3} = -\frac{5}{2}\frac{(n-p)^5+p^5}{n^3(n-p)^2p^2} + 1\frac{5}{2}\frac{(n-p)^4-p^4}{n^4(n-p)p}\frac{m}{y_m}$$
$$-\frac{5}{8}\frac{(n-p)^3+p^3}{n^5}\frac{13m^2-4}{y^2_m} + \frac{5}{8}\frac{(n-2p)(n-p)p}{n^5}\frac{m(6m^2-7)}{y^3_m}$$
$$-1\frac{1}{48}\frac{(n-p)^2p^2}{n^6}\frac{31m^4-101m^2+28}{y^4_m} \quad \text{.....(xxiv).}$$

And thus:

$$\chi_p = s\frac{\lfloor n}{\lfloor n-p \lfloor p}\frac{(n-p)^{n-p}p^p}{n^n}\sqrt{2\pi}\sqrt{\frac{(n-p)p}{n^3}}\frac{1}{y_m}\{1+c_1+c_2+c_3+\ldots\} \quad \text{.....(xxv).}$$

The solution of the problem is now purely arithmetical, although of course laborious.

(5) We may note some special cases.

Corollary (i). *Suppose both n and p large and not nearly equal.*

Since if q be large

$$\lfloor q = \sqrt{2\pi q}\, q^{-q} e^{-q},$$

we have

$$\chi_p = s\frac{1}{n\,y_m}\{1+c_1+c_2+c_3+\ldots\} \quad \text{.....(xxvi),}$$

a much simpler form.

Corollary (ii). *Suppose n large and p small.*

$$\chi_p = s\frac{\sqrt{2\pi p}\,p^p e^{-p}}{\lfloor p}\frac{1}{n y_m}\{1+c_1+c_2+c_3+\ldots\} \quad \text{.....(xxvii).}$$

Corollary (iii). Suppose n large, and that we consider Mr Galton's special problem of the ratio of the distance between the first and second to the distance between the second and third in a graduated array. Then

$$\frac{\chi_1}{\chi_2} = \frac{e}{2\sqrt{2}}\frac{y'_m}{y_m}\frac{1+c_1+c_2+c_3+\ldots}{1+c_1'+c_2'+c_3'+\ldots} \quad \text{.....(xxviii),}$$

where undashed letters refer to quantities for $p=1$ and dashed letters to the same quantities when $p=2$.

(6) As a first series of illustrations, let us apply these results to Mr Galton's consideration of the proportion of money to be given in prizes, supposing only two prizes, for the cases $n=3$, 10, 50, 100, 1000.

The following table contains the chief values*. We write:

$$\chi_p = s \times \phi(p)(1+c_1+c_2+c_3+\ldots) \quad \text{.....(xxix).}$$

Then, if $d_{rr'}$ be the difference measured in variability units between the r^{th} and r'^{th} individuals,

$$d_{rr'} = \{\chi_r + \chi_{r+1} + \chi_{r+2} + \ldots\ldots + \chi_{r'-1}\}/s,$$

* I owe to Dr Alice Lee, not only a careful revision of my numbers, but an extension of this table.

and Mr Galton takes as a reasonable measure of the prizes $100d_{13}/(d_{13}+d_{23})$ and $100d_{23}/(d_{13}+d_{23})$ per cent. of the prize money. These are obtained from the last two rows of the table.

Table of Data for Two-Prize Ratios.

$n=$	3	10	50	100	1000
m	·43074	1·28155	2·05375	2·32635	3·09040
$\log y_m$	$\bar{1}$·560,6213	$\bar{1}$·244,2739	$\bar{2}$·685,0071	$\bar{2}$·425,7300	$\bar{3}$·527,0311
m'	−·43074	·84162	1·75069	2·05375	2·87830
$\log y_{m'}$	$\bar{1}$·560,6213	$\bar{1}$·447,0995	$\bar{2}$·935,3726	$\bar{2}$·685,0071	$\bar{3}$·801,9239
$\phi(1)$	·833,910 *	·524,952 *	·380,906 †	·345,992 †	·274,009 †
$\phi(2)$	·833,910 *	·342,013 *	·222,691 †	·198,170 †	·151,399 †
c_1	+·004,736	+·031,971	+·070,072	+·084,161	+·119,233
c_2	+·011,633	−·005,875	−·032,216	−·042,268	−·066,830
c_3	−·002,055	+·000,204	+·002,068	+·001,656	−·001,876
$1+c_1+c_2+c_3$	1·0143	1·0263	1·0399	1·0435	1·0505
c_1'	+·004,736	+·007,686	+·027,170	+·035,035	+·055,246
c_2'	+·011,633	+·002,355	−·010,553	−·016,108	−·030,375
c_3'	−·002,055	−·000,327	+·000,443	+·000,517	−·000,170
$1+c_1'+c_2'+c_3'$	1·0143	1·0097	1·0171	1·0194	1·0247
$\chi_1/s=d_{12}$	·8458	·5388	·3969	·3611 ‡	·2879
$\chi_2/s=d_{23}$	·8458	·3453	·2265	·2020 ‡	·1551
$d_{13}/(d_{13}+d_{23})$	·667	·719	·733	·736	·741
$d_{23}/(d_{13}+d_{23})$	·333	·281	·267	·264	·259

The results are in fairly close agreement with those obtained from Mr Galton's investigation, which puts the first and second individuals in the places they would hold if the sample of the competitive population were actually arranged according to the normal law. His proposition that if there be two prizes they should embrace 75 and 25 per cent. respectively of the prize money is seen to be a sound rule for practical purposes when n is at all large, and might well be impressed upon the powers that rule such distributions not only in the educational world, but in rifle, athletic, sporting and agricultural competitions.

(7) We may next consider how the divergencies between individual members of an array vary when we take the pair close to one end of the array, or nearer to the centre. Let us suppose the array to contain 100 individuals; we already know the differences between the 1st and 2nd, and the 2nd and 3rd individuals. We will now find the differences between the 25th and 26th and the 50th and 51st. In other words we will determine $\chi_{25}(100)$ and $\chi_{50}(100)$. We can easily find these expressions in the more general case for n fairly large§; we have:

$$\chi_{\frac{1}{2}n}(n)=s\times\frac{2\cdot506,628}{n}\left(1+\frac{\cdot035,398}{n}-\frac{\cdot012,327}{n^2}\right)\ldots\ldots\ldots\ldots\ldots\ldots\text{(xxx)}$$

and

$$\chi_{\frac{1}{2}n}(n)=s\times\frac{3\cdot146,865}{n}\left(1+\frac{\cdot072,942}{n}-\frac{\cdot026,989}{n^2}\right)\ldots\ldots\ldots\ldots\ldots\ldots\text{(xxxi).}$$

* Calculated from (xxv).

† Calculated from (xxvii).

‡ Mr W. F. Sheppard sends me as the values for these constants deduced by quadratures ·3594 and ·2018, which thus show that our method is sufficiently approximate.

§ i.e. using (xxvi).

These will give the corrective terms in the brackets close enough, even if n be as small as 10. The terms outside the brackets will need determining by (xxvii) instead of (xxvi) if n be less than 30, say. We see that (xxx) gives us the average difference between the mediocre individuals and (xxxi) the difference between two individuals at the quartile. Roughly the differences in the two cases are as 5 to 6. But if we compare the extreme individuals' difference for $n=100$, we have

$$\chi_1 = \cdot 3611 \times s, \quad \chi_2 = \cdot 2020 \times s, \quad \chi_{25} = \cdot 0315 \times s, \quad \chi_{50} = \cdot 0251 \times s.$$

Thus the interval between extreme individuals is more than ten times the interval between mediocre individuals.

Now, of course, the normal distribution in a general sort of way indicates that the differences between modal, or what the biologists term 'normal,' individuals are very small. But Mr Galton's difference problem enables us for the first time to quantitatively appreciate how much wider the differences are between the extreme (or biologists' 'abnormal' individuals) and modal (or normal) individuals. Now the range of a distribution being somewhat about $6s$, we see that extreme individuals may be separated by as much as $\frac{1}{17}$ of the range, while modal individuals have only a difference of $\frac{1}{250}$th of the range, and even individuals at the quartile only a difference of $\frac{1}{200}$th of the range.

It is not possible to pass over the general bearing of such results on human relations. If we define 'individuality' as difference in character between a man and his immediate compeers, we see how immensely individuality is emphasised as we pass from the average or modal individuals to the exceptional man. Differences in ability, in power to create, to discover, to rule men, do not go by uniform stages. We know this by experience, but we see it here as a direct consequence of statistical theory, flowing from a characteristic and familiar chance distribution. We ought not to be surprised, as we frequently are, at the results of competitive examination, where the difference in marks between the first men is so much greater than occurs between men towards the middle of the list. In the same way the individuality of imbeciles and criminals at the other end of the intellectual and moral scales receives its due statistical appreciation.

We stand in a better position to judge the pathological from the merely exceptional, mere isolation no longer leads us to doubt the position of an extreme outlying error, observation or individual*.

In short Galton's difference problem leads us to look upon samples of populations and even on populations themselves, no longer as arrays of continuously varying individuals, but as systems of discrete units. We see discontinuity in every sample and in every population. We obtain a new and most valuable conception of a normal or standard population. It is one in which each individual is separated from his immediate neighbours, when the whole is arranged according to any character, by definite calculable intervals. These intervals are, of course, the *average* intervals which would be found by taking the mean of many such samples or populations, but they are none the less of extreme suggestiveness. Just as the *continuous* representation by a frequency curve is only an ideal representation of the observed facts, so we now reach an ideal representation of the actual *discontinuity* in the given population. As in the case of many physical investigations, so we find in statistical theory both continuous and discontinuous representations of the phenomena equally important and equally valid within the legitimate limits of interpretation.

(8) As a last illustration I propose to investigate the value of χ when $n=2$, and $p=1$. We easily find:

$$m=0, \quad y_m = \frac{1}{\sqrt{2\pi}},$$

* I propose on another occasion to consider the application of Galton's problem to a new theory for the rejection of outlying individuals.

and from (xxii)...(xxiv):

$$c_1=0, \quad c_2=\cdot 017{,}699, \quad c_3=-\cdot 003{,}081,$$
$$\chi=s\times 1\cdot 127.$$

Since a_5 the next term vanishes, I believe this result is probably true to the last figure. Anyhow I think we may say that if the individuals be taken at random from a population, then the probable value of the standard deviation of that population is nearly $\frac{23}{20}$ of the difference between the two individuals. Thus by averaging the differences between pairs of individuals taken at random we can obtain fairly readily an appreciation of the standard deviation, i.e. the variability of the general population. Further, if we take individuals, not quite at random, but from correlated groups, e.g. pairs of brothers selected at random, the $\frac{23}{20}$th of the average difference of the pairs will be the standard deviation of the correlated groups, e.g. a group of brethren; hence the degree of relationship between such correlated individuals may be determined. This is only a suggestion of one of the many possible uses of Galton's difference problem. It opens up, indeed, many new methods of inquiry, the effectiveness of which, however, can only be tested by their application in actual statistical practice. It must suffice for the present to have indicated that this difference problem marks a new, and very probably a most important, departure in statistical theory.

KARL PEARSON.

THE RELATION OF BINARY FISSION TO VARIATION.

By J. Y. SIMPSON, D.Sc.

It has hitherto been commonly assumed that binary fission as a method of reproduction amongst unicellular organisms is mere duplication, and that the daughter-products of the process are exactly alike. The generalisation was probably in the first instance botanical; thence it spread to zoology, and from lack of investigation has been accepted within the most recent times*. Its use in theory is obvious. In binary fission we do not look for variation; accordingly we are left with an excellent rationale of conjugation, and so, finally, of sexual reproduction, viz. a means to produce variation in the interests of evolution. As the result of certain considerations I have been led to the view that binary fission is not mere duplication, and that the products of such division are more or less unlike. A similar conclusion has been already reached by Ernest Warren in his studies on Parthenogenesis. Thus in a paper entitled "An Observation on Inheritance in Parthenogenesis"† he states: "From twenty-three Daphnia, themselves originating from Parthenogenesis, broods were produced consisting of three to six individuals. The parents were measured, and the offspring were allowed to grow up. On measuring the offspring it was at once obvious that the children of the same brood exhibited very considerable variability."

Perhaps it should be stated here that the contention is not that there is *always* variation in binary fission. Of this I have very little doubt, but it would be exceedingly difficult, perhaps impossible, to prove; for where the variation was not quantitative it might be qualitative. Indeed there were many instances where the products of binary fission did appear to be singularly alike, and they might well have been called duplicates so far as their qualities were revealed by a magnification of 625, but these instances were by no means the majority. On the other hand there were also numerous instances where even with a magnification of 105 it was evident on careful examination that there was considerable dissimilarity between the daughter forms.

* Adam Sedgwick's Presidential Address, Section D, *Report of British Association for* 1899, pp. 759, 760.

† *Proceedings of the Royal Society*, Vol. LXV. p. 155.

The species that I have specially examined in this connection are *Paramœcium caudatum* and *Stylonichia pustulata*, but the data submitted in this paper deal only with *Paramœcium*. The points to which attention was directed were:—

(*a*) the total length,

(*b*) the extreme breadth,

(*c*) the index $\frac{\text{breadth}}{\text{length}}$.

In (*a*) differences in daughter forms were found ranging from 0 to 25μ, and in (*b*) from 0 to 20μ. A difference of from 1 to 20μ was also found in the distance between the two contractile vacuoles.

It will be noticed that greater length in one member of a divided pair was not necessarily associated with less breadth.

The following Table gives the lengths and maximum breadths in each of 100 pairs of *Paramœcium caudatum*, expressed in μ, the unit of measurement being 5μ. It also gives the value of the index $\frac{\text{length}}{\text{breadth}}$.

The differences in general outline—e.g. one of the daughters was sometimes found to have a distinctive bend or curve in its contour—were best brought out by means of micro-photography. As micro-photography has not as yet been generally applied to living *Ciliata*, I give a few notes on the method employed. Ordinary Ilford chromatic plates were used, as also a Leitz 3 lens, which with the associated extension gave a magnification of about 80. The pictures were all taken instantaneously by incandescent light. The proportion of failures was very high, about 70 per cent. The chief difficulty was in obtaining a cell small enough to be wholly included within the magnification of the lens. Ultimately a block of soft paraffin was employed in which a hole was pierced with a fine needle. It was then sectioned with the microtome, and in this way by regulating the thinness of the section, a cell was obtained with the minimum of water in which the infusorian could live and yet be in focus all the time. A cover-glass was then superimposed, and as it was held in position by a generous application of vaseline round the edge, I was able to take the photographs in a horizontal position. Some of the photographs were sadly lacking in definition, but it is a matter of extreme difficulty to calculate and adapt that amount of water in the cell which is sufficient for the free movement and life of the protozoon and yet is not too great to allow it to get out of focus during the exposure.

An interesting question is raised as to the exact stage at which these measurements should be taken so as to represent this variation in its truest and greatest degree. It is very natural to suppose that for some little time after division the two daughter *Paramœcia* will be imperfectly formed, e.g. across the line of fission: we may imagine that the posterior end of the anterior daughter and the anterior end of the posterior one are not fully developed, as

TABLE I.

Length, Breadth, and Breadth-Length Index in each member of 100 *Pairs of Paramœcium caudatum, produced by asexual division.*

First Member			Second Member			First Member			Second Member			First Member			Second Member		
Length	Breadth	Index	Length	Breadth	Index	Length	Breadth	Index	Length	Breadth	Index	Length	Breadth	Index	Length	Breadth	Index
265	65	·245	245	60	·245	225	65	·289	220	65	·295	245	75	·306	235	85	·362
280	65	·232	275	55	·200	215	70	·326	210	70	·333	235	75	·319	230	70	·304
250	45	·180	230	50	·217	230	70	·304	210	90	·429	230	80	·348	220	70	·318
270	60	·222	250	70	·280	220	80	·364	210	85	·405	205	85	·415	200	85	·425
285	85	·298	280	85	·304	225	55	·244	215	60	·279	230	65	·283	230	60	·261
255	70	·275	250	75	·300	215	65	·302	200	70	·350	255	75	·294	250	75	·300
185	70	·378	180	65	·361	200	75	·375	200	75	·375	250	70	·280	245	60	·245
230	75	·326	220	70	·318	220	85	·386	220	75	·341	200	55	·275	195	60	·308
215	70	·326	210	80	·381	225	65	·289	225	65	·289	265	70	·264	250	65	·260
210	65	·310	195	75	·385	245	70	·286	240	75	·313	255	75	·294	245	80	·327
175	50	·286	170	55	·324	230	70	·304	230	65	·283	250	80	·320	245	80	·327
240	70	·292	235	80	·340	230	70	·304	220	65	·295	240	65	·271	230	60	·261
210	55	·262	200	55	·275	235	65	·277	225	65	·289	220	70	·318	220	65	·295
240	70	·292	230	85	·370	240	55	·229	225	55	·244	225	60	·267	220	65	·295
245	70	·286	235	65	·277	245	65	·265	245	60	·245	220	55	·250	210	60	·286
235	75	·319	225	70	·311	230	70	·304	220	60	·273	250	75	·300	245	80	·327
220	75	·341	215	70	·326	225	60	·267	220	55	·250	255	70	·275	250	70	·280
240	65	·271	235	75	·319	230	60	·261	225	60	·267	260	90	·346	255	85	·333
280	80	·286	270	65	·241	220	60	·273	215	65	·302	230	55	·239	215	60	·279
250	70	·280	245	75	·306	235	70	·298	220	70	·318	220	60	·273	205	65	·317
210	70	·333	205	70	·341	215	70	·326	215	70	·326	240	65	·271	225	65	·289
185	65	·351	185	60	·324	250	75	·300	245	75	·306	220	55	·250	205	55	·268
225	80	·356	225	75	·333	240	65	·271	235	70	·298	235	55	·234	235	50	·213
190	55	·289	175	65	·371	255	80	·314	245	70	·286	275	85	·309	275	75	·273
250	65	·260	240	70	·292	275	80	·291	275	75	·273	205	65	·317	200	60	·300
240	75	·313	230	80	·348	265	75	·283	250	70	·280	215	55	·256	205	60	·293
200	60	·300	190	60	·316	230	55	·239	205	60	·293	250	75	·300	235	70	·298
170	60	·353	165	55	·333	300	95	·317	300	95	·317	235	70	·298	220	75	·341
200	55	·275	190	55	·289	235	85	·362	225	75	·333	210	60	·286	210	55	·262
220	75	·341	200	75	·375	250	65	·260	245	60	·245	250	75	·300	250	75	·300
230	60	·261	220	65	·295	190	60	·316	185	55	·297	250	80	·320	245	65	·265
220	65	·295	210	60	·286	235	60	·255	225	60	·267	255	70	·275	245	80	·327
235	60	·255	220	60	·273	230	60	·261	225	70	·311	225	65	·289	205	70	·341
												240	70	·292	230	70	·304

indeed would appear to be the case for a short interval. Accordingly one should perhaps wait till the daughters are full-grown: on the other hand it may then be objected that the differences that are noticeable may be due to feeding or some modification of the environment. On the whole probably the fairest time at which to make the comparison is just shortly after division. I have attempted comparison at both stages. The measurements are taken at intervals of from one to thirty-two hours after division. A few further observations and statistics show a continued tendency to vary in the second generation.

The correlations between divided individuals have been determined for length, breadth, and the index $\frac{\text{breadth}}{\text{length}}$.

The compilation of the correlation tables was undertaken, and the computations connected with them were performed by Miss Lee, D.Sc., whose assistance I would gratefully acknowledge. The values obtained are given in the following tables:—

TABLE II.

Constants of the Series.

Organ	Mean	Standard Deviation
Length	229·050	19·152
Breadth	68·125	9·155
Index	29·913	4·029

TABLE III.

Correlations.

Organs	Correlations
Lengths of 1st and 2nd Members	·914 ± 0·011
Breadths of 1st and 2nd Members	·782 ± 0·026
Breadth of 1st and Length of 2nd Member	·447 ± 0·054
Index of 1st and 2nd Members	·664 ± 0·038
Length and Breadth of 1st Member	·421 ± 0·055

These values are remarkably high, compared with the homotypic values obtained by Professor Pearson in a large number of cases among animals and plants. Among the causes which obviously tend to raise the apparent correlation between the members of a pair resulting from division are (1) differences in the length of time which elapsed between division and measurement, involving the inclusion in the Table of individuals differing considerably in age; (2) differences in the treatment of different pairs, which the most careful culture cannot wholly prevent. The second of these causes can hardly be allowed for; an attempt was however made to provide a means of estimating the effect of the first, by measuring a smaller series of individuals at known intervals of time after division, and again at a known interval of time after the first measurement. The difficulties of restoring the individuals to normal conditions of life after a first measurement were so great that the series obtained is small: and the measurements were made at a different time of year. The principal difficulty is associated with the artificial means employed to quiet the protozoa so as to admit of accurate measurements being made. Many methods have been suggested, from the use of narcotics down-

wards. I found the application of 5°/₀ solutions of gelatine to be as effective and less deleterious than any other agent. But it is obvious that the differences in environment—from a normal medium to one to which such gelatine has been added—when repeated more than once especially within a short period for purposes of measurement must have some influence upon later growth even when the greatest care is taken, and it is highly probable that this influence is seen in the difference in index correlation to which Professor Pearson calls attention in his note below.

Note on Dr Simpson's Memoir on *Paramœcium caudatum*.

(1) Dr Simpson's results are clearly not purely homotypic as far as the correlations between pairs of members are concerned, but largely affected by the growth factor, the measurements of pairs having been made at all sorts of intervals after division. They cannot therefore be used in their present condition as a means of appreciating homotyposis in the results of linear division. In order to reach pure homotyposis we must obtain measurements of growth in length and breadth during a variety of periods after division. The labour, however, of obtaining measurements on pairs of members at a definite interval after division being very great, Dr Simpson was only able to provide the set of measurements in the accompanying Table IV. These involve eleven pairs measured twice and three of them measured thrice. It will be seen at once that the growth is very irregular, and even more so in breadth

TABLE IV.

	Divided	Measured	Length	Breadth	Measured	Length	Breadth	Measured	Length	Breadth
1st pair	May 22, 11 a.m.	5 p.m.	210	70	May 23, noon	225	75	May 24, 11.30 a.m.	225	80
			230	55		245	65		245	70
2nd pair	May 22, 11 a.m.	4.30 p.m.	230	80	May 23, 1 p.m.	240	90			
			245	70		260	90			
3rd pair	May 22, 10 a.m.	4 p.m.	225	60	May 23, 1.30 p.m.	230	75			
			220	60		225	70			
4th pair	May 22, 5 a.m.	10 a.m.	210	75	May 23, 12.30 p.m.	220	75	May 24, noon	225	75
			220	75		230	75		235	80
5th pair	May 22, noon	5.30 p.m.	240	85	May 23, 1.15 p.m.	245	85	May 24, 1.30 p.m.	245	85
			230	80		235	80		235	80
6th pair	May 22, 6 a.m.	3 p.m.	220	65	May 23, 4 p.m.	230	70			
			215	70		220	75			
7th pair	May 23, 5.30 p.m.	6.30 p.m.	175	65	May 24, 1 p.m.	230	85			
			180	60		240	80			
8th pair	May 23, 4.30 a.m.	6 p.m.	195	60	May 24, 1.30 p.m.	230	80			
			220	70		245	90			
9th pair	May 23, 4 a.m.	6.15 p.m.	230	60	May 24, 12.30 p.m.	250	70			
			215	75		240	90			
10th pair	May 23, 4 a.m.	6.45 p.m.	225	70	May 24, noon	260	95			
			235	65		270	85			
11th pair	May 23, 1 p.m.	5.45 p.m.	205	60	May 24, 2 p.m.	220	75			
			230	70		235	90			

than in length. Thus of the six individuals measured thrice, four exhibited no change at all in length, three no change at all in breadth during the last 24 hours. It seems therefore that individuals either cease growing at a certain interval after division or else have periods of rest. The unit of 5μ does not seem sufficiently small to obtain accurate results for breadth measurements. For, anything between 72·5 and 77·5 would be registered as 75. But anything just below 72·5 or just above 77·5 would be registered as 70 or 80 respectively. Thus a real growth just less than 5μ might not appear at all, and a real growth just greater than 5μ might appear as a growth of 10μ. As the standard deviation in breadth for the whole series is less than twice 5μ, this cannot fail to have serious influence in dealing with such a short series as 11 pairs. Hence the conclusions reached below are purely tentative, but they will suffice to show the importance of allowing for the growth factor in dealing with like cases of homotyposis.

(2) In order that we may safely apply the results deduced for growth from the present series to Dr Simpson's earlier series, we must determine whether the former may, as far as its statistical constants are concerned, be considered a random sample of the latter. Accordingly the new measurements were taken as if they had been 44* original measurements of length, breadth, etc., on separate individuals.

TABLE V.

Constants of Two Series.

Organ	Mean		Standard Deviation		Coefficient of Variation	
	100 series	44 series	100 series	44 series	100 series	44 series
Length	229·050	227·954	19·152	18·099	8·361	7·940
Breadth	68·125	74·205	9·155	9·997	13·439	13·472
Index	29·913	32·557	4·029	3·470	—	—
Interval from division in hrs.	—	18·023	—	11·153	—	—

TABLE VI.

Correlations of Two Series.

Organs	100 series	44 series
Lengths of 1st and 2nd Members	·914 ± ·011	·698 ± ·074
Breadths of 1st and 2nd Members	·782 ± ·026	·574 ± ·097
Breadth of 1st and Length of 2nd Member†	·447 ± ·054	·641 ± ·060
Indices of 1st and 2nd Members	·664 ± ·038	·114 ± ·100
Length and Breadth of 1st Member† ...	·421 ± ·055	·594 ± ·066

* In order not to weight individuals and to leave the series as homogeneous in age-variation as possible the three pairs measured thrice were only included as far as their first two measurements are concerned.

† It is a remarkable result that breadth of second member is more highly correlated than breadth of first member with length of first member in both Dr Simpson's series. How far is some element of "compensation in division" indicated?

The least examination of these two series shows that one cannot be considered as a random sample of the other. Not only are the means of breadth and index sensibly different, but there has been a general lowering of the direct and a raising of the cross-correlations, which is far beyond the limits suggested by even the large probable errors. As for the index-correlation, its immense change is very mysterious*. There has been either considerable change in environment, in average interval from division at which measurements were taken, or, as suggested in (1), the breadth to 5 μ is really not close enough to get consistent results.

It appears therefore that, as the second series cannot be looked upon as a random sample of the first, it would be idle to attempt to use results for growth deduced from it to correct for the growth factor the values of the correlations obtained in the first series. Accordingly all that seemed possible was to apply the growth results obtained for the short series to the correlations obtained for the short series and so reach some appreciation of the screening influence of growth on pure homotyposis.

(3) The interval after division was accordingly correlated with length, breadth and index for the 44 cases, with the following results:

TABLE VII.

Interval and Size.

Organ	Correlation
Length and Interval ...	·547 ± ·071
Breadth and Interval...	·538 ± ·072
Index and Interval ...	·273 ± ·094

It will be seen at once that growth-correlation is a most sensible factor in the resemblance between individuals when pairs of them are measured at the same interval after division. It is least for the index, but is quite sensible even in this case. In other words, the index is a more reliable character than absolute length or breadth to deduce *pure* homotyposis from†, but clearly the average percentage growths in length and in breadth are not equal, and accordingly the index itself alters with the interval from division.

The lengths between 3 and 38 hours interval from division were plotted to the intervals; the results were, of course, very irregular, but a straight line certainly would represent them as effectively as any curve. For the data available accordingly the regression line of age and size was taken as the average curve of growth. In other words, for an organ x the growth in time τ was taken to be $\frac{r_{xt}\sigma_x}{\sigma_t}\tau$, where r_{xt} was the correlation for interval from division and size tabled above in VII, σ_x the standard deviation of the organ x and σ_t that of the intervals of time given in Table V. Thus if x be the observed size of an organ at time t its most probable size, at the mean interval $\bar{t}$ after division, would be

$$x' = x - \frac{r_{xt}\sigma_x}{\sigma_t}(t - \bar{t}).$$

* The value of the index-correlation was also determined for the second series indirectly from the formula *R. S. Proc.* Vol. 60, p. 493. The value found was ·130, which agrees as well as could be expected with the direct value ·114 given above.

† Used by K. Pearson for gills of mushrooms and by E. Warren for ivy leaves for this reason: see *Phil. Trans.* Vol. 197, A, pp. 240, 338.

Let y be the observed size of any other organ at the same interval after the mean time, then its probable size at the mean time is given by

$$y' = y - \frac{r_{yt}\sigma_y}{\sigma_t}(t - \bar{t}).$$

Clearly means of x' and y' will be equal to means of x and y, and we easily find*

$$\sigma^2_{x'} = \sigma^2_x(1 - r^2_{xt}), \qquad \sigma^2_{y'} = \sigma^2_y(1 - r^2_{yt}) \quad \text{.....(i)}$$

$$R_{x'y'} = \frac{\rho_{xy} - r_{xt}r_{yt}}{\sqrt{1 - r^2_{xt}}\sqrt{1 - r^2_{yt}}} \quad \text{..... (ii)}$$

where $R_{x'y'}$ is the correlation of the x' and y' characters allowing for growth and ρ_{xy} of x and y, or without allowance for growth.

If x and y are the same organ for the pair, we have

$$R = \frac{\rho - r^2}{1 - r^2} \quad \text{..... (iii)}$$

where r is the correlation of growth and interval of time for the organ in question.

If we apply these formulae to the values of ρ given in Table VI and to the values of r_{xt} given in Table VII, we deduce the values of the homotypic correlations, when allowance is made for growth. We find

TABLE VIII.

Homotyposis allowing for Growth †.

Lengths of 1st and 2nd Members	·569 ± ·074
Breadths of 1st and 2nd Members	·400 ± ·151
Length of 1st and Breadth of 2nd Member ...	·491 ± ?
Indices of 1st and 2nd Members	·043 ± ?
Length of 1st and Breadth of 1st Member ...	·425 ± ?

The first two of these results are quite as satisfactory as we could expect from such data. They fit in fairly well with the homotypic correlation distribution clustering about ·5. The fourth is very improbable. But the drop from ·664 to ·114 in index correlation between Dr Simpson's first and second series of measurements is so inexplicable that we cannot possibly expect anything from the index figures. The third result clearly does not satisfy the theorem I have given for cross-homotyposis‡. But the lowness of the index correlation, and the fact that the length of the 1st member is more highly correlated with the breadth of the 2nd member than with that of the 1st would undoubtedly be explicable, if, as I have suggested, there be some principle of "compensation in division" at work. We can only hope that at some future time we may have available a much more extensive system of growth measurements, made on the *same* long series as the homotypic measurements. Without this correspondence it is impossible to distinguish how much of the degree of resemblance between members resulting from the same division is due to growth and how much to pure homotyposis. But the results for growth in Table VII combined with those for pure homotyposis in Table VIII suffice to show that great care must be used in not treating what are really coefficients of gross resemblance as in Table V—due to pure homotyposis + growth + individual environment of the pairs of members—as in any way a proper measure of the first factor, i.e. of pure homotyposis only.

* These formulae may be obtained by straightforward algebra from the above results, but they are really simple cases of a theory developed at length in an unpublished memoir on "Selection allowing for Growth"; (ii) is clearly the partial correlation coefficient for the time-factor constant.

† Probable errors in first two cases calculated from unpublished formulae.

‡ *Phil. Trans.*, Vol. 197, A, p. 287.

A SECOND STUDY OF THE VARIATION AND CORRELATION OF THE HUMAN SKULL, WITH SPECIAL REFERENCE TO THE NAQADA CRANIA.*

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(1) *Introductory and Historical.*

THE present investigation was commenced in 1895, but the long series of measurements involved and the elaborate numerical calculations necessary, have delayed the completion of the work until the present time. It forms part of a more general scheme for determining the size, variability and correlation of the chief organs and characters in man, which has been in progress at University College for

* The Editors of *Biometrika* have been assisted in publishing this memoir in its present form by the allotment by the President and Council of the Royal Society of a grant for this purpose from their Publication Grant Fund.

† I am responsible for the editing and arrangement of Miss Fawcett's material. The present memoir is to some extent a product of cooperation among the biometric workers at University College. On Miss Fawcett, however, by far the most arduous part of the task has fallen. K. P.

some years past. When this scheme was started but little had been done to obtain a scientific measure of the variability and correlation of the parts of the human body. Innumerable anthropometric, including craniometric measurements, had been made and published but very little had been done in determining scientifically their statistical constants. In fact there was considerable danger that the want of proper statistical theory would bring the science of craniology into discredit with archaeologists. The manner in which variation is dealt with even in such a classical work as Rütimeyer and His's *Crania Helvetica* is astonishing to the statistician who has realised the nature of the distribution of any character in a homogeneous population. A considerable population can be measured and we can determine whether or no it is sensibly differentiated from a second statistically defined population. But to classify a few individuals into different races by means of two or three measurements, such as the cephalic index, the length, or the facial angle,—before the correlation and the variation of these characters have been determined for even a single race—is a very dangerous proceeding, and calculated to bring craniometry into discredit*.

It was with a view accordingly of providing anthropologists with the needful constants for determining racial differences that the scheme spoken of was started. It consisted partly in the reduction of existing published measurements, and partly in the measurement of new and large series, where such were not already available. A fairly comprehensive series of determinations of variability in man were made by Dr Alice Lee, Mr G. U. Yule, and Professor K. Pearson, and published by the latter in his *Chances of Death and other Studies in Evolution*, Vol. I. pp. 256—277. Further a considerable quantity of new material was collected and reduced in a series of papers entitled: *Data for the Problem of Evolution in Man*, published by the Royal Society in their *Proceedings* and *Transactions*.

The first really scientific determination of the variability of the skull was published by Stieda in 1882†, but the value of his paper lies only in the hint that the mathematical methods used by Quetelet and Galton in anthropology ought to be applied to craniology. He does not apply his method to any extensive series of comparative results nor extend it to tests of racial differentiation. A much more complete series for the variation of the parts of the skull is given in the paper in *The Chances of Death* referred to above (see pp. 323—372). The first determination of the correlation of any parts of the skull was, we believe, made in 1895 and published by Professor Pearson in his memoir on *Regression, Heredity, and Panmixia*‡. He correlated length and breadth of skull in modern Germans, modern French, and in the Naqada crania. which had just then reached England. Further correlation results, giving the values in the case of length, breadth, and

* Nothing is here said of the power of distinguishing races which an anatomical craniologist may possess after long experience of types. But many such craniologists make their *ultimate* appeal—and this without the requisite statistical knowledge—to craniometry and not to anatomical appreciation.

† "Ueber die Anwendung der Wahrscheinlichkeitsrechnung in der anthropologischen Statistik." *Archiv für Anthropologie*, Bd. XIV. SS. 167—182.

‡ *Phil. Trans.* Vol. 187, A, pp. 279—281.

height, and of the two cephalic indices, were published in the memoir on *Spurious Correlation* of 1896*. Soon after this Dr Alice Lee took up the subject and wrote an academic dissertation on the correlation of the skull in 1899, which appeared in the *Phil. Trans.* as *A First Study of the Correlation of the Human Skull*†. Her memoir deals chiefly with the correlation between the capacity of the skull and its length, breadth, and height for a variety of races, but incidentally a good many other correlations are considered. Meanwhile Dr Franz Boas had published in 1899 an interesting paper especially drawing attention to the correlation of the cephalic index with the capacity‡. Roughly we may say that the result of these investigations is to show:

(i) that the correlation of the parts of the skull varies remarkably from one local race to a second;

(ii) that the correlation of the measurements most commonly made is remarkably small, as compared with that of the principal dimensions of the human body, e.g. the long bones of the skeleton or the bones of the hand.

These conclusions, definite as far as they go, rather strengthened than weakened the need of the investigation we had been for some years engaged upon. Our object was to determine in this "Second Study of the Correlation of the Human Skull" whether, confining our attention to a single race and dealing with a greater range of characters, we should find any more highly correlated than those referred to above. We desired further to place before the reader the full statistical treatment of a large series of skulls, adopting the modern methods of reduction, with a view, if possible, of making these methods more generally known to craniological investigators. The publication of raw material is always of value, but we are convinced that until the statistical constants for variation and correlation have been calculated for such material, but little can be safely asserted as to racial relationship from purely craniometric investigations.

(2) *Material.*

The great difficulty of the statistician in approaching craniological problems is the absence of sufficient material. This is an unavoidable difficulty which must be faced. It is very hard to obtain a homogeneous group of skulls, even 50 in number, and these again must be distributed between the two sexes. The probable errors therefore of constants determined from such series are proportionately large. For statistical purposes much of the craniometric data published by anatomists is hopelessly inadequate, and if we are to trust reliable craniometric judgments rather than anatomical appreciations§, we must impress upon craniologists the

* *R. S. Proc.* Vol. 60, p. 495.

† *Phil. Trans.* Vol. 196, A, pp. 225—264.

‡ *The American Naturalist*, N. S. Vol. 1. p. 448.

§ We do not contest the value of the anatomical appreciation in the hands of the master, but we do contest the cloaking of such appreciation by an apparent array of craniometric data, which are statistically inadequate.

need to largely increase the number of crania dealt with, whenever this can be done without introducing doubts as to homogeneity.

In our present investigation we have been lucky in obtaining,—not what the mathematician would term a statistically adequate series, we cannot get skulls like crabs, butterflies, or leaves by the thousand, but—an unusually long series for a craniometric investigation. Professor Karl Pearson requested Professor Flinders Petrie before he left for Egypt in 1894 to procure for him if possible 100 skulls of a homogeneous race. Early in 1895 Professor Petrie reported that he was able to send to England a remarkably fine anthropological collection—the entire skeletons as well as crania—of the now well-known Naqada race, embracing more than 400 individuals. This collection was packed and brought to England at the expense of the late Mr A. B. Pearson-Gee, who, hearing that the project might fall through, generously provided the requisite funds. The whole material was deposited at University College, where Mr Herbert Thompson in 1895 made for Professor Pearson five measurements on 301 skulls; these were used in Professor Flinders Petrie's *Naqada and Ballas.* In 1896 Dr Ernest Warren undertook the measurement of the chief bones of the skeletons, and his results were published in the memoir of 1897: *An Investigation of the Variability of the Human Skeleton: with especial reference to the Naqada Race**. Shortly after, at the suggestion of Professor Pearson, Miss C. D. Fawcett undertook to complete the measurements on the crania. We have thus during a number of years had at our disposal a splendid collection of upwards of 400 skulls. We cannot too heartily thank Professor Flinders Petrie for his kindness in this matter. We are also much indebted to Dr E. Warren for aid. Where possible his sexing of the skeletons has been adopted for the sexing of the skulls, because that sexing was based on a very careful process (*loc. cit.* p. 138) of examination of the long bones, the hip-bones, and the skulls. When this determination was not available appeal was made to Professor G. Thane's determination of sex used in the case of the skulls measured by Mr Herbert Thompson. Lastly in those cases—fairly numerous—in which the skulls had no corresponding skeletons or had not been sexed by Professor Thane, Dr Warren has most kindly come to our aid, and given us his judgment as to sex. It will be found in the tables that the skulls are classed as male (♂), female (♀), doubtful but probably male (♂ ?), doubtful but probably female (♀ ?), and finally sex quite doubtful (?). For the remarks on the anatomical peculiarities of the skulls placed in the last column of the tables of the appendix of measurements we have to thank in particular Professor W. F. R. Weldon, F.R.S., who most kindly went through the whole series with this end in view, and Professor G. Thane who examined some thirty selected crania.

* *Phil. Trans.* Vol. 189, B, pp. 135—227.

(3) *Brief Account of the Naqada Race.*

Some details as to the Naqada race may be stated here. We owe this summary to the ready response of Professor Flinders Petrie to an appeal for aid in this matter. At Naqada in Upper Egypt there existed one of the largest prehistoric cemeteries yet known, in which about 2000 graves were opened by Professor Petrie and his fellow-workers in the early months of 1895. Since then other cemeteries at Abadiyeh, Hu, and other sites have also been excavated, and the general results have been summed up in *Diospolis Parva*, 1901. The conclusion reached is that the prehistoric cemeteries of Egypt date approximately between 7000 and 5000 B.C., or we may consider the Naqada crania as about 8000 years old. The people whose remains were thus discovered were highly skilful in mechanical work, such as flaking flints and cutting vases in the hardest stones, but they had small skill in copying animate forms. In this they contrast strongly with the artistic powers of the next race, who founded the dynastic history. The portraiture remaining of the prehistoric people shows at the beginning a few examples of the steatopygous race of Bushman type; these are always female figures and perhaps represent the last captive survivors of palaeolithic man in Egypt. The great body of the race was of one type, strongly like the races on either hand of Egypt, the Libyans of Africa, and the Amorites of Syria. The small difference of cephalic index between the prehistoric Egyptians and the cognate peoples of modern Algeria (1800 miles distant and 8000 years later) is even less than that between modern Italians and their forefathers 2000 years earlier. The type in external appearance may be summed up from portraiture as having a well-formed head with finely domed top; a long, slightly aquiline nose; good lips, and a pointed beard. The hair was brown*, abundant and wavy; the eyes, as shown in paintings of the Amorites, were blue.

(4) *Measurements made and Methods of Measurement.*

In determining what measurements should be made on the Naqada crania, we were largely guided by the following consideration: one or another measurement may be ideally good from the anatomist's standpoint, but the chief use of craniometry is for comparative purposes, and what will be of most value will be, not to add new types of measurement, however desirable in themselves, but to make such measurements as will bring the Naqada skulls into relationship with as many measured series as possible. Now there can be no doubt, we think, that the German system as expressed in the concordat of the German craniologists known as the *Frankfurter Verständigung*, whatever be the defects of its individual measurements, covers, in the great catalogue of the German anthropological

* Some of the skull-boxes contained the dry scalp with the hair upon it in a remarkable state of preservation. It was a dark brown in short curly twists. In two cases there were locks of some brilliant golden hair, but on careful examination, for which I have to thank Dr W. A. Osborne, dark brown single hairs were extracted from it, and it appeared that the whole had been *bleached*; possibly, this is the earliest case on record of the hair-dyer's handicraft.

collections, by far the largest mass of material yet measured by a nearly uniform system. It will take an army of calculators their lifetimes to reduce that raw material to statistical shape. Accordingly we have largely adopted* the series of measurements and the nomenclature of the Frankfurt Concordat as the basis of our treatment of the Naqada skulls. One or two exceptions to this (as the inclusion in our tables of Flower's ophryo-occipital length, which had already been taken by Mr Herbert Thompson) will be dealt with below.

The *Frankfurter Verständigung über ein gemeinsames craniometrisches Verfahren* was settled at a meeting of the German Anthropological Society held at Frankfurt, August 14–17, 1882, and has been accepted by Kollman, Virchow, Ranke, Ecker, His, Schwalbe, Welcker, v. Török, Stieda, Rüdinger, and other well-known German craniological investigators. It was first published in the *Correspondenz-Blatt d. deutsch. anthrop. Gesellsch.* Bd. XIV. S. 1, and offprints may be obtained from Prof. J. Ranke in Munich†. The fundamental conception of this concordat is the measurement of lengths and angles in relation to a certain conventional plane now termed the "German horizontal plane." This plane is defined as:

> Jene Ebene, welche bestimmt wird durch zwei Gerade, welche beiderseits den tiefsten Punkt des unteren Augenhölenrandes mit dem senkrecht über der Mitte der Ohröffnung liegenden Punkt des oberen Randes des knöcheren Gehörganges verbinden.

Unfortunately for this definition the four points defining two straight lines—the two lowest points on the under rims of the eye-sockets and the two highest points on the upper rim of the auricular passages—do not necessarily lie in one plane, although the divergence from coplanarity as a rule has small importance. In the present case the craniophor to be presently described swings the skull from the highest points of the upper rims of the auricular passages‡, and the third point to determine the horizontal plane was taken from the under rim of the left eye-socket, when this was available, as was generally the case.

The determinations of the horizontal plane were made by a Ranke's craniophor and a Spengler's pointer belonging to Professor Pearson. These were made for him by Bernard Wiedermann of Munich, who also provided a Ranke's goniometer. These instruments were made under the personal supervision of Prof. J. Ranke, whom we have to thank for his great kindness in this matter. The craniophor, the Spengler's pointer, and the goniometer are illustrated in the accompanying plate, and a fuller description of them is given by Professor Ranke himself in his *Beiträge zur physischen Anthropologie der Bayern*, Bd. II. S. 11 *et seq.* The fundamental idea of the craniophor is a couple of horizontal bars with axes in the same line, which can be inserted in the auricular passages, so that the skull swings freely from the uppermost points of the upper rims of the auricular orifices.

* With one important exception: see p. 415.

† A reprint with modifications, the source of which is not apparently stated, is given by E. Schmidt: *Anthropologische Methoden*, Leipzig, 1888, pp. 320–31.

‡ The line through these two points will be spoken of as the auricular axis.

Alternative bars are provided in case these orifices are very small. On the base of the instrument is a pointed rod, which can be clamped in any position, and which enables the operator to fix a third point on the base of the skull. Spengler's pointer is merely a scriber, the horizontal awl or pointer of which can be set to the top line of the horizontal bars. It is then moved to the front of the skull, and this is turned round its auricular axis until the lowest point of the under rim of the eye-socket is in contact with the point of the awl. The skull is then held in this position by adjusting the pointed clamping rod attached to the base.

A horizontal rod sliding on a graduated vertical bar attached to one of the supports of the "auricular axis," then gives the auricular height of the skull, that is, the vertical height of the skull measured perpendicular to the horizontal plane in a line perpendicular to the auricular axis. The goniometer is an instrument almost sufficiently described by its figure. It consists of two parallel horizontal bars terminating in points, which retaining their parallelism can be moved at will in a vertical plane. The points of these two bars can be brought into contact with any two points of the skull in one vertical plane. A rod can then be adjusted so as to be paralled to the line joining these two points, and the angle between this line and the horizontal is read off on a protractor scale attached to the instrument.

The *Frankfurter Verständigung* defines the horizontal length—*gerade Länge*—of the skull as follows:

> Von der Mitte zwischen den Augenbrauenbogen, *arcus superciliares*, auf den Stirn-Nasenwulst, zu dem am meisten vorragenden Punkt des Hinterhaupts parallel mit der Horizontalebene des Schädels gemessen.

A footnote states that the measurement may be taken with the callipers or Spengler's craniometer, but the adjustment to the median and horizontal planes is not described. We adopted the following method which had been previously used by Professor Pearson for taking the horizontal length. The craniophor was placed in use upon a drawing-board covered with good millimetre ruled paper, the auricular axis of the instrument was adjusted so as to be parallel to the ruling. A solid truly vertical block made by the Cambridge Instrument Company was now brought in contact with the back of the skull and its bottom edge brought parallel to the ruling. This gave us a true vertical tangent plane to the skull parallel to the auricular axis. The Concordat says nothing about the measurement of the horizontal length, when the most projecting point of the back of the skull does not lie in the median plane. Such skulls frequently occur, and in such cases the horizontal length as above defined would be skewly measured. We have always taken it *horizontal and perpendicular to the auricular axis.* A similar block cut away above the base, but having a projection of the same thickness as the base and capable of adjustment to any position or height, was then brought in contact with the most projecting point of the forehead with one or both superciliary ridges, or the *glabella** as the case might be, and its base made parallel to the auricular

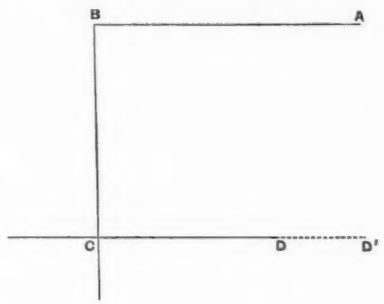
* A projecting edge on the front block allows the measurement to be *always* made from the glabella itself when this is preferred.

Fig. 1.
Craniophor and Block-Squares.

Fig. 2.
Craniophor, Goniometer, and Scriber.

axis by means of the millimetre paper. The horizontal length of the skull was then determined by measuring with a millimetre scale the distance between the bases of the vertical blocks. This was measured on both sides of the blocks to insure that they were truly parallel. It will be seen that this measurement diverges somewhat from the *gerade Länge* of the Frankfurt Concordat. But the *gerade Länge* as measured by the German craniologists with the *callipers*, the eye judging of the horizontality of the instrument, seems to us liable to an error of 1 to 2 millimetres—an error of the same order as the thickness of the superciliary ridges. Taken with the callipers in nine cases out of ten it will be found to agree with the German horizontal length, and in the tenth it is very difficult to determine whether the difference is due in part or not to the hand in holding the callipers. The length determined by aid of the blocks described above would be the exact horizontal length of the skull, if photographed to life size by a camera on the auricular axis at a considerable distance, or it would be the horizontal length of a projection on a plane perpendicular to the auricular axis made by a line parallel to that axis and moving round always in contact with the surface of the skull. We shall consider below what differences there are in mean and variability, of the length of the skull as measured in the three different ways*.

Finally attention may be drawn to the spanner used, which is rectangular in shape and graduated on three sides. It was devised by Professor J. Ranke but is a modification of Virchow's spanner. Diagrammatically it consists of three rods $ABCD$, of which CD can be pulled out to D' so that AD' is parallel to BC, and further CD can be slid parallel to AB along BC.



Thus by taking BC parallel to any given direction it is possible by one adjustment to determine the distance between AD resolved along and perpendicular to this direction, i.e. we can read off BC and DD'. By this instrument the vertical difference in height of points not necessarily in the same vertical line can be obtained with considerable accuracy. In addition to these instruments we used a steel tape and a small pair of callipers.

* Measurements by Mr A. Martin Leake showing how slight are the differences produced by using the English or German methods are cited by Pearson: *The Chances of Death*, Vol. I. p. 270.

The following forty-eight measurements and indices were found for the skulls as far as their condition allowed of the determination:

(*a*) Capacity. Our method of measuring this is dealt with at length below (*C*).*

(*b*) Flower's ophryo-occipital length. From ophryon to occiput measured with the callipers (*F*).

(*c*) Greatest length, from glabella to the most projecting point at the back of the skull (*L*).

(*d*) Horizontal length, measured as described above (*L'*).

(*e*) Greatest horizontal breadth of the skull, measured with the callipers (*B*).

(*f*) Least breadth of forehead, from one temporal line to the other, as measured with the callipers (*B'*).

(*g*) Height of skull, from the middle of the anterior edge of the *foramen magnum*, the basion, to the point on the top of the skull vertically above it, perpendicular to the German horizontal plane, measured with the callipers with the skull on the craniophor (*H*).

(*h*) Auricular height, measured with vertical scale and sliding rod of craniophor (*OH*). See p. 414. For skulls which cannot be placed on the craniophor, the auricular height has been determined by the distance from the auricular axis (see p. 413) to a point on the sagittal suture 2—3 cms. behind its meeting point with the coronal suture, or behind the bregma. Taken with callipers described above, *D* being inserted in the auricular orifice and *CD* being made to coincide as closely as possible with the auricular axis "by appreciation." Such height is marked by (*h*) in the Tables of measurements.

(*i*) Length of skull base, from the basion to the middle of the fronto-nasal suture, the nasion (*LB*).

(*j*) Horizontal† circumference of the skull, measured directly above the superciliary ridges and round the most projecting point of the back of the head with the steel tape (*U*).

(*k*) Sagittal or median circumference of the skull, measured from the nasion over the top of the head to the middle of the posterior rim of the *foramen magnum*, or the opisthion. Taken with the steel tape (*S*).

(*l*) Cross-circumference of the skull, measured in a vertical plane (perpendicular to the "horizontal plane") from the upper rim of one auricular passage to that of the other. Taken with the steel tape (*Q*).

(*m*) Face height, measured from nasion to the lowest median projection of the mandible. Measured with the callipers (*GH*).

(*n*) Upper face height, measured from the nasion to the middle of the central process of the upper jaw between the middle incisor teeth, i.e. the alveolar point. Taken with the callipers (*G'H*).

* Letters in brackets indicate the symbols used for each measurement.

† Not necessarily 'horizontal' in the sense of the "horizontal plane."

(*o*) Face breadth, being the distance from one zygomatic maxillary suture to the other. The measurement must be taken from the lower end of these sutures, from the lower front rim of one cheek-bone to that of the other. Taken with the callipers (*GB*).

(*p*) Zygomatic breadth, from the outermost point of one zygomatic arch to the like point on the other. Taken with the callipers (*J*).

(*q*) Nasal height, measured from the nasion to the lowest edge of the pyriform aperture. Taken with small callipers (*NH*).

(*r*) Nasal breadth, greatest breadth of the nasal aperture, wherever it may be. Taken with small callipers (*NB*).

(*s*) Breadth of orbit (O_1), for both left (*L*) and right (*R*) eyes; the greatest breadth from side to side of orbit wherever found, measuring from inner margin to inner margin. Taken with small callipers (see p. 430, below).

(*t*) Greatest height of orbit (O_2), for both left (*L*) and right (*R*) eyes; taken as closely as possible perpendicular to O_1 by aid of small callipers.

(*u*) Length of palate (G_1); measured from the point of the *spina nasalis posterior* to the inner wall of the alveolar rim between the middle incisors, with small callipers (see p. 429, below).

(*v*) Breadth of palate (G_2); between the alveolar walls at the second molars. With small callipers.

(*w*) Profile length. From the basion to the alveolar point (*GL*).

(*x*) Condylar width (W_1). Greatest width of mandible at condyles, from outside of one condyle to outside of second. With callipers.

(*y*) Angle width (W_2). Greatest width of mandible at angles; from outside of one angle to outside of the other. With callipers.

(*z*) Greatest height of mandible (h_1); measured from lowest median projection to top of process between middle incisors. With small callipers.

(*zz*) Distance between *foramina mentalia*. With small callipers.

From these measurements the following indices were determined:

(α) The cephalic index (100 B/L') for greatest length.

(β) The cephalic index (100 B/L) for horizontal length.

(γ) The ratio of height to length (100 H/L') for greatest length.

(δ) The ratio of height to length (100 H/L) for horizontal length.

(ϵ) The height to breadth index (100 H/B).

(ζ) The breadth to height index (100 B/H).

The determination of both (ϵ) and (ζ) was for purposes of spurious correlation: see p. 461, below.

(η) The face height to face breadth index (100 GH/GB).

(θ) The upper face height to face breadth index (100 $G'H/GB$).

(κ) The nasal breadth to nasal height index (100 NB/NH).

(λ) The orbital height to orbital breadth index for both right and left eyes (100 $O_2/O_1 \,.\, R$ and 100 $O_2/O_1 \,.\, L$).

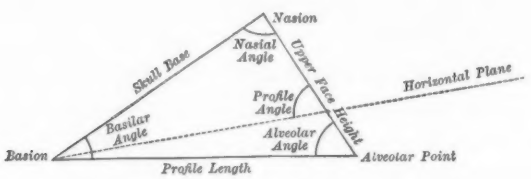
(μ) The palate breadth to palate length index (100 G_2/G_1).

(ν) The length to breadth index (100 L'/B) for greatest length.

(π) The length to height index (100 L'/H) for greatest length.

(ν) and (π) again were only calculated as subsidiary calculations involved in other investigations.

A knowledge of the profile length (GL), the skull basis (LB), and the upper face height ($G'H$) gave us the sides of the triangle formed by the mid-point on the frontal nasal suture, the nasion, the mid-point on the alveolar rim between the middle incisors, the alveolar point, and the mid-point of the anterior rim of the *foramen magnum*, the basion.



We placed these lengths on the trigonometer made for Professor Pearson by the Cambridge Instrument Company, and read off at once the three angles of this triangle*. But knowing the profile angle we were able to discover the angles between the skull base and the profile length and the horizontal plane. We have therefore besides the profile angle the following five angles:

(*aa*) Profile angle (P), measured with Ranke's goniometer as described above: p. 414.

(*bb*) Angle between upper face length and profile length, the *alveolar angle* ($A\angle$). Determined by length measurements and trigonometer as above described.

(*cc*) Angle between skull basis and upper face length, the *nasial angle* ($N\angle$). Determined as in (*bb*).

* Professor Thane having much emphasised the importance of these angles, the trigonometer in question was devised for readily obtaining them with sufficient practical accuracy.

(*dd*) Angle between skull basis and profile length, the *basilar angle* ($B\angle$). Determined as in (*bb*).

(*ee*) Angle between skull basis and the German horizontal plane (θ_1), the *basio-nasal horizontal angle.* Determined as in (*bb*), with the use of profile angle as found by goniometer.

(*ff*) Angle between profile length and the German horizontal plane (θ_2), the *basio-alveolar horizontal angle.* Determined as in (*ee*).

Of the six angles, we are inclined to lay most stress on $A\angle$, $N\angle$, and $B\angle$. We found considerable difficulty in determining the profile angle $P\angle$ with satisfactory accuracy from the goniometer, and of course a knowledge of θ_1 and θ_2 depends on the knowledge of $P\angle$.

(5) *On the Determination of the Capacity.*

We devote a special section to the consideration of the method of determining the capacity. In the first place this is admittedly a difficult point even in sound skulls; in the next place our skulls were exceedingly fragile, and notwithstanding very great care in the handling, more than one came to pieces in the process of measurement. Shot of course cannot be used with skulls 7000 to 8000 years old, and even sand is dangerous, so that we only used it for a comparatively few crania. Again, in many of the crania there was a considerable amount of caked and dry desert sand. To extract this by gentle tapping or shaking was an extremely difficult process, and a good deal of it was practically unreachable by any other method. Rough tapping would of course quicken the extraction, but might easily end in the destruction of the skull. In the moving about of the skulls and their handling in the course of their six years at University College most of this desert sand has, we think, been got rid of, but we believe that the smaller values of the capacity found by Mr Herbert Thompson for the same skulls, are to some extent, but by no means entirely, due to the imperfect elimination of this sand. In the next place the difficulty of getting out all the material, sand or seed, placed in a fragile skull is very real, and after testing we found it equally satisfactory to measure our material before it was put in, and not on removal. Thus complete removal of the material from the skull was unnecessary, and a double system of shaking on putting in and taking out was avoided. We commenced by filling the measuring glass with more material than required for the skull, shaking down and reading off. Then we filled the skull, shaking and tapping so far as possible, then we measured the comparatively small remainder, shaken down again in the measuring glass, and the difference gave the skull capacity.

In order to test the observer's own agreement with herself thirty skulls were measured, using (1) mustard seed, (2) rape seed, and (3) silver sand. The method with each material was the same. The results are as follows:

TABLE I.

Capacity of Thirty Skulls, diversely measured.

No.	Sex	Mustard	Rape	Sand
1212	♂	1273	1275	1265
1474	♀	1347	1345	1340
1483	♀	1378	1379	1372
1586	♂	1305	1310	1300
1587[1]	♂	1445	1440	1435
1651	♂	1288	1283	1295
1666	♂	1300	1303	1295
1683	♀	1245	1243	1245
1743	♀	1327	1325	1317
Q. 408[c]	♀	1305	1302	1300
1890	♂	1425	1420	1410
Q. 83	♂	1398	1397	1395
1787	?	1557	1545	1525 ?*
1804	♀	1274	1272	1270
1814[b]	♀	1215	1220	1220
1825	♀	1200	1205	1205
1827	♀	1187	1190	1190
1875	♂	1285	1288	1285
1878	♂	1310	1315	1308
Q. 466[4]	♂	1260	1265	1255
B. 5	♀	1355	1365	1345
B. 21	♀	1225	1225	1218
T. 19	♂	1353	1358	1356
T. 23	♀	1280	1275	1265
T. 23[d]	♂	1253	1260	1250
T. 23[f]	♂	1277	1280	1270
T. 29[A]	♂	1220	1230	1225
15	♀	1187	1185	1180
121	♀	1445	1440	1435
724	♀	1205	1205	1200
Mean		1304·1	1304·8	1299·0

Now these results are in very fair agreement, if anything the estimate by sand is slightly less than those by seed. The remainder of the skulls were only done twice, once by mustard seed and once by rape seed, and this merely for verification. Clearly the same person using different material, sand and seed, and consequently rather different methods of packing can obtain results in good agreement among themselves. But if different persons repeat the process or use a different process will they reach sensibly the same values?

Now some of the Naqada skulls were measured independently by four different observers. Thus the capacity of No. 1308 as determined by Professor Thane (mean of two determinations) was 1201, Mr Quebell (mean of two) 1238, H. Thompson (mean of two) 1214, and by C. D. Fawcett (mean of three) 1217. Again, *B* 24[b] was determined by Professor Thane at 1454, by H. Thompson at 1481 and by C. D. Fawcett at 1497. Further, *B* 21 was estimated by Professor Thane at 1156,

* The skull broke under the last measurement, so that it is somewhat doubtful.

by Herbert Thompson at 1173 and by C. D. Fawcett (mean of three determinations) at 1222. Of course some of this difference may be due, as we have suggested, to the gradual elimination of more of the desert sand, but the bulk of it was undoubtedly personal equation. Either C. D. Fawcett packed less tightly in the measuring glass or more tightly in the skull, than H. Thompson did; either way the result is that there is a difference in the determinations which may run up to 20 or 30 cm.^{3}, and much the same holds, if either of our estimates are compared with those of the far-more practised Professor Thane. We look upon the capacity-determination as subject to large personal equation, and we do not see how to correct it. As we got practically identical results with seed or sand, so we believe different observers watching each other's methods would rapidly learn to do the same, but whether such accordant results would give the true capacity of the skull, we are more inclined to doubt.

Herbert Thompson measured 39 male and 55 female Naqada crania. C. D. Fawcett measured 69 males and 98 females. Further, Dr Alice Lee has estimated the mean capacity of these crania from the values of length, breadth and height measured by C. D. Fawcett*. She has also determined from the Leipzig collection of Theban mummy skulls the mean capacity of 201 males and 96 females†. The following are the results:

TABLE II.

Mean Capacity.

Material	Sex	No.	Mean Capacity
Naqada (H. Thompson)	♂	39	1339
" "	♀	55	1243
Naqada (C. D. Fawcett)	♂	69	1387
" "	♀	98	1279
Naqada (Dr Lee's Formula)	♂	69	1377
" "	♀	98	1255
Ancient Egyptians	♂	201	1390
" "	♀	96	1254

Now allowing for the difference of the sample it is clear that there must be a large personal equation element in the differences between H. Thompson and C. D. Fawcett, upwards of 30 to 40 cm.^{3} Roughly weighting his and her ♂ series at 6 and 8, his and her ♀ series at 7 and 10 respectively, we find:

Mean capacity for Naqada ♂ crania = 1366,

" " " " ♀ crania = 1264.

* *Phil. Trans.* Vol. 196, pp. 225—264.

† *Loc. cit.* p. 246. A longer series of Egyptian mummies with much the same results is given by Pearson: *Chances of Death*, Vol. I. p. 339.

Personally we would give no greater weight to these results, which took days and days of laborious measurement, than we would to the values 1377 and 1255 obtained in a few minutes from the length, breadth and auricular height by Dr Lee's formula*. Nor should we be prepared to admit any difference upon which an argument as to race might fairly be based between our measurements on the Naqada skulls, Dr Lee's estimate of their capacity, or the values given for the capacity of the ancient Egyptians†. We think it reasonable to suppose the skull capacity of the male Naqada to have been 1370—1380 cm.^{3} and of the female 1250—1260 cm.^{3}, and that there is no sensible change in capacity between this proto-Egyptian race and the Theban people, whose crania are classed as 'mummy skulls' at Leipzig. We shall compare these Egyptians in other characters later with the Naqada race.

(6) *On the Degree of Homogeneity possessed by the Naqada Crania.*

It seemed of importance to determine whether our material might fairly be treated as homogeneous, and Professor Petrie kindly provided us with a list which divided the graves into three classes, namely interments of 30—40 S.D., those of 41—69 S.D., and the latest, of 70—80 S.D. As many skulls as possible were dated roughly from this list, but these were unfortunately a very small proportion of the whole number. Professor Petrie tells us that the smaller and poorer graves which contained only one or two indistinctive pots were not worth plundering, so that in these the skeletons and skulls were found intact. On the other hand the richer graves with plenty of good and distinctive pots had nearly all been plundered, and the skull had very possibly been destroyed or had perished in the process. Hence in very many cases, where the skull was found no dating was possible.

We selected length and breadth as suitable characters and obtained the following results:

TABLE III.

Mean L and B for early and late groupings.

	No.	I 30—40 S. D.	No.	II 40—80 S. D.	No.	III Whole Series‡
L ♂	13	184·88	5	183·45	129	184·64
L ♀	23	177·98	9	175·00	163	177·08
B ♂	13	131·71	6	137·92	129	134·82
B ♀	21	129·54	9	131·53	163	131·31

* *Loc. cit.* "mean formula" Table XIX., p. 244.

† The more so as the great disproportion of the sexes for the ancient Egyptians suggests that certain of the larger ♀ crania have been sexed as ♂ crania.

‡ The results here and in Table IV. were deduced from smaller series than were found ultimately available for Tables V. and IX.

Now it will be noticed that the numbers for the later period are quite insignificant, so small indeed as to be largely affected by age at death of the individuals. We can hardly get a real random age distribution in 5 to 9 skulls!

Turning first to the length, the means and standard deviations of I, II and III were calculated and hence the probable error of the differences of the means was found. The results were as follows:

$$\begin{aligned}
♂\ M_{\mathrm{I}} - M_{\mathrm{III}} &= \quad \cdot2413 \pm \cdot9882 \\
♂\ M_{\mathrm{II}} - M_{\mathrm{III}} &= -1\cdot1933 \pm 2\cdot0817 \\
♂\ M_{\mathrm{I}} - M_{\mathrm{II}} &= \quad 1\cdot4346 \pm 2\cdot2534
\end{aligned}$$

Thus in no case was there a sensible difference in length, within the limits of random sampling, of the three groups.

For the females

$$\begin{aligned}
♀\ M_{\mathrm{I}} - M_{\mathrm{III}} &= \quad \cdot8943 \pm \cdot5570 \\
♀\ M_{\mathrm{II}} - M_{\mathrm{III}} &= -2\cdot0840 \pm 1\cdot2746 \\
♀\ M_{\mathrm{I}} - M_{\mathrm{II}} &= \quad 2\cdot9783 \pm 1\cdot3589
\end{aligned}$$

The differences here are all larger than their probable errors, but only in one case slightly more than twice the probable error. It is impossible again to assert that there is a real class difference.

Turning now to the breadth we have

$$\begin{aligned}
♂\ M_{\mathrm{I}} - M_{\mathrm{III}} &= -3\cdot1152 \pm \cdot7221 \\
♂\ M_{\mathrm{II}} - M_{\mathrm{III}} &= \quad 3\cdot0938 \pm 1\cdot3378 \\
♂\ M_{\mathrm{I}} - M_{\mathrm{II}} &= -6\cdot2090 \pm 1\cdot4703
\end{aligned}$$

Now these differences appear significant; in two cases they are four times and in the third case twice their probable errors. But on closer examination of the individual crania we doubted whether the apparent sensibility of the differences in the first and third lines is not largely due to the existence of two or three rather juvenile skulls in the first series.

For the females

$$\begin{aligned}
♀\ M_{\mathrm{I}} - M_{\mathrm{III}} &= -1\cdot7674 \pm \cdot6367 \\
♀\ M_{\mathrm{II}} - M_{\mathrm{III}} &= \quad \cdot2278 \pm \cdot8208 \\
♀\ M_{\mathrm{I}} - M_{\mathrm{II}} &= -1\cdot9952 \pm \cdot9831
\end{aligned}$$

The last two results are hardly to be classed as sensible differences, the first is possibly such.

If the reader will now turn to the frequency diagrams for the breadth of skull in ♀ and ♂ (p. 445) he would expect to find in the former modes at about 129·5 and 131·5 and in the latter modes at 132 and 138, if there be a real difference in the two series of early and late skulls. The conspicuous female maxima are at

126, 131 and 133·5 and the conspicuous male maxima at 131, 135 and 138·5. This again is very inconclusive agreement.

Lastly, if the material were markedly heterogeneous the variability in breadth and length of skull ought to be large as compared with admittedly homogeneous material. We give some comparative results in the following table of standard deviations and coefficients of variation:

TABLE IV.

Variability in L and B of Naqada Crania compared with Homogeneous Series.

Series	L ♂		L ♀		B ♂		B ♀	
	S. D.	C. of V.	S. D.	C. of V.	S. D.	C. of V.	S. D.	C. of V.
Naqada ...	5·722	3·092	5·247	2·963	4·612	3·421	4·490	3·420
Bavarian* ...	6·088	3·371	6·199	3·571	5·849	3·887	4·891	3·394
Aino*	5·936	3·195	5·453	3·077	3·897	2·759	3·662	2·677
French† ...	7·202	3·966	6·435	3·651	6·068	4·206	5·062	3·674
English‡ ...	6·446	3·435	6·536	3·665	4·976	3·554	5·062	3·781

Judged by length we see that for both sexes the Naqada series is less variable than Bavarian, Aino, French, and English. Judged by breadth the Naqada are more variable than the Aino, less than French and English and differ little from the Bavarian skulls. Accordingly it would appear that the Naqada series is quite comparable in homogeneity with any modern series of skulls of like number, even with such very homogeneous material as the "Altbayerisch" crania of Professor Ranke and the Whitechapel crania of Professor Thane. We think therefore that we are justified in treating our material as homogeneous and in speaking of a Naqada *race* and not merely of the Naqada crania.

(7) *Mean Values of the Cranial Characters of the Naqada Race and their Comparison with those of allied and other Races.*

The accompanying Tables V[a] and V[b] contain our principal results for the mean values of the chief characters. We give the number of skulls dealt with for each mean and the probable errors calculated in the usual manner. We also give for comparison the values which were available for the following races:

(*a*) Maciver's measurements on the earliest inhabitants of Abydos reduced by Miss M. A. Lewenz and Professor Pearson. These results are based on very

* Dr A. Lee: *Phil. Trans.* Vol. 196, A, p. 230.

† Deduced by C. D. Fawcett from Broca's measurements of the skulls in the Paris catacombs.

‡ Unpublished measurements on Professor Thane's Whitechapel Skulls.

few crania and the measurements as stated in Maciver's tables, not sufficiently definite to give the indices accurately*.

(*b*) Ancient Theban Mummies. The means were found by Professor Pearson and Dr Alice Lee from Dr E. Schmidt's measurements published in the Leipzig portion of the German Anthropological Catalogue. Their date is approximately 1500 B.C.

(*c*) Modern Egyptian skulls collected chiefly by Mook from a cemetery near Cairo, extracted from the German Anthropological Catalogue, and reduced by Dr Alice Lee. They are almost certainly Copts.

(*d*) Modern Negroes from the North of Africa. These have been extracted from the German Anthropological Catalogue, and were reduced by Mr N. Blanchard.

Another table (see Table VI.) for modern Negroes but for a few characters only is given later. These were chiefly from Algiers, the Soudan and the West Coast

* We must express our entire disagreement with the method of exhibiting measurements adopted in D. Randall Maciver's *The Earliest Inhabitants of Abydos*, Oxford, 1901. His series are somewhat smaller than ours, running in each case from about 20 to 60 measurements. He says that they belong to two, and perhaps, to three periods. Now it is perfectly certain that no graphical method will enable us to distinguish in the case of small frequency distributions like this whether a divergence is due to random sampling or to difference of race. We can only proceed as we have attempted to do in Art. 6 by calculating the means and their probable errors, and then ascertaining the degree of significance of the differences. Mr Maciver has not given us a single mean, a single variability, or a single probable error. Until he does this no statistically trained craniologist would venture to draw any conclusions whatever from his results. To those who know the large errors of random samples when the sample consists of not more than 20 to 60 individuals, especially in the case of low correlation, it will be an obvious truth that no conclusions at all can be drawn from the graphical display of these results. For variation the rough observations must be replaced as we have endeavoured to do by the smooth curves. For correlation, the only profitable proceeding is to calculate by Bravais' formula the coefficient of correlation. Hundreds of correlation tables have been formed and published by the workers at University College during the last few years, but although our numbers are often twice to thrice Mr Maciver's, we refrain from publishing a single correlation table on the present occasion. We feel quite convinced that a correlation table with even 100 entries is in 9 cases out of 10 only misleading to the *eye*. What we want is the correlation coefficient and its probable error. For example in Table 14 Mr Maciver gives the correlation table of breadth and height of orbit for male skulls, only 27 in number! We see no conclusion whatever which can be safely drawn from a mere table of this kind. Although when we state for this race that the correlation between breadth and height of orbit is ·43 ± ·06, we can at once make a comparison with other races, and present our material in an intelligible form to the trained statistician. On p. 2 of his memoir Mr Maciver states: "The methods commonly employed for recording anthropometrical data are unsatisfactory in the extreme.....Those who realize the importance of full publication yet usually content themselves with flinging together simple lists. Even for a small series of examples such a list is cumbrous and when the series is a long one it becomes most tedious and distracting. The entire labour of tabulation is left to be done by the reader who must be possessed of exceptional patience to undertake it at all." We can only criticise this by saying that Mr Maciver leaves the entire labour of calculation to be done by the reader, and that we should have been grateful had he flung a simple list together. Throughout his measurements never once apparently has a skull stood midway between two units! It is impossible to read the indices accurately, and to determine such an important correlation as that between the orbital and nasal indices would take hours of work and "a reader possessed of exceptional patience," if indeed it could be properly done at all. For some purposes Mr Maciver's tables might possibly be of use as a supplement to a "simple list," but we trust sincerely they may not again *replace* ordered Tables of measurement.

TABLE V^a. *Comparison of Naqada Means with those of other Races.*

MALE.

Character and Reference Letter	Naqada and allied Races										Unallied Races			
											Advanced		Primitive	
	Naqadas		Maciver's Prehistoric Egyptians		Theban Mummies		Modern Egyptians		Modern Negroes		'Altbayerisch' (Modern German)		Aino	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
(*a*) *C*	88	1381·0 ±7·7	—	—	164	1387·63	59	1356·1	39	1347·7	100	1503·5	76	1462
(*b*) *F*	121	183·96± ·37	44	182·36	—	—	—	—	—	—	—	—	—	—
(*c*) *L*	139	185·13± ·33	42	184·50	169	181·94	60	177·03	39	182·85	100	180·58	88	185·8
(*d*) *L'*	121	184·87± ·37	—	—	—	—	—	—	—	—	—	—	88	184·6
(*e*) *B*	139	134·87± ·26	42	132·38	169	136·63	59	136·76	39	133·15	100	150·47	88	141·2
(*f*) *B'*	140	91·06± ·27	—	—	168	93·83	60	94·08	32	95·91	72	103·70	88	96·2
(*g*) *H*	134	135·21± ·31	34	133·94	169	136·05	59	137·24	39	135·31	99	133·78	88	139·5
(*h*) *OH* ...	140	115·59± ·25	—	—	169	114·34	60	116·07	27	115·04	100	120·75	88	119·3
(*i*) *LB*	109	99·34± ·31	24	100·92	169	100·63	59	100·95	27	102·96	85	100·30	88	105·4
(*j*) *U*	118	511·02± ·81	—	—	168	510·76	59	501·76	32	508·47	99	524·35	88	522·5
(*k*) *S*	119	373·02± ·74	—	—	168	372·44	59	365·95	32	367·72	80	365·10	77	372·8
(*l*) *Q*	116	304·22± ·63	—	—	169	306·07	59	311·81	27	306·85	87	329·70	84	328·5
(*m*) *GH* ...	28	112·02± ·76	—	—	151	114·31	23	115·74	29	115·21	—	—	53	118·3
(*n*) *G'H* ...	85	67·59± ·30	22	70·64	169	68·78	56	68·69	31	68·00	56	70·80	73	69·8
(*o*) *GB* ...	82	95·85± ·37	—	—	161	95·66	56	95·29	27	96·63	49	95·10	76	102·1
(*p*) *J*	53	125·63± ·48	22	126·45	166	128·33	57	125·82	32	129·47	56	135·00	74	137·3
(*q*) *NH* ...	91	48·94± ·21	25	50·36	169	50·61	59	50·68	27	49·52	70	50·90	79	50·5
(*r*) *NB*	86	25·12± ·14	25	25·10	166	25·26	58	24·93	34	27·29	70	24·80	78	25·6
(*s*) O_1L ...	82	43·11± ·16	27*	38·07	169*	38·14	59*	38·15	27	39·56	71*	39·90	79*	40·9
(*s'*) O_1R ...	81	42·60± ·16												
(*t*) O_2L ...	80	32·67± ·17	27*	32·67	169*	32·96	59*	32·49	27	34·19	71*	33·72	79*	34·9
(*t'*) O_2R ...	72	31·87± ·18												
(*u*) G_1	75	55·80± ·28	—	—	160	46·25	52	47·10	26	49·42	56	44·30	75	53·0
(*v*) G_2	75	40·33± ·29	—	—	151	40·83	52	39·98	26	39·73	53	33·20	74	38·2
(*w*) *GL* ...	81	94·72± ·34	24	96·12	169	95·79	45	97·47	27	105·33	—	—	69	104·9
(*x*) W_1	41	110·49± ·87	—	—	153	118·08	12	112·92	16	117·00	—	—	61	102·0
(*y*) W_2	51	93·58± ·67	—	—	154	97·08	13	95·31	16	97·15	—	—	—	—
(*z*) h_1	60	32·91± ·28	—	—	—	—	—	—	—	—	—	—	59	33·8
(*z'*) *f*	49	44·44± ·25	—	—	—	—	—	—	—	—	—	—	—	—
(*aa*) *PL* ...	62	84°·41± ·25	—	—	47	85°·49†	13	84°·15	11	82°·00	40	89°·10	67	82°
(*bb*) *AL* ...	73	72°·82± ·32	—	—	—	—	—	—	—	—	—	—	—	—
(*cc*) *NL* ...	73	66°·60± ·30	—	—	—	—	—	—	—	—	—	—	—	—
(*dd*) *BL* ...	73	40°·73± ·22	—	—	—	—	—	—	—	—	—	—	—	—
(*ee*) θ_1	62	28°·29± ·29	—	—	—	—	—	—	—	—	—	—	—	—
(*ff*) θ_2	62	11°·30± ·34	—	—	—	—	—	—	—	—	—	—	—	—
(*a*) 100 *B*/*L'* ...	101	72·70± ·19	—	—	—	—	—	—	—	—	—	—	—	—
(*β*) 100 *B*/*L* ...	130	72·99± ·17	42	71·78	169	75·07	59	77·27	39	72·87	100	83·20	88	76·5
(*γ*) 100 *H*/*L'* ...	98	73·20± ·18	—	—	—	—	—	—	—	—	—	—	—	—
(*δ*) 100 *H*/*L* ...	131	73·30± ·16	34	72·60	169	74·71	59	77·46	39	74·15	99	74·20	88	75·6
(*ε*) 100 *H*/*B* ...	131	100·47± ·28	34	101·18	169	99·64	59	100·56	39	101·75	—	—	—	—
(*ζ*) 100 *B*/*H* ...	131	99·76± ·27	34	98·84	169	100·36	59	99·44	39	98·28	99	89·10	88	98·8
(*η*) 100 *GH*/*GB*	25	117·06± ·72	—	—	148	112·20	23	120·74	23	113·02	—	—	49	115·9
(*θ*) 100 *G'H*/*GB*	76	70·63± ·35	—	—	155	72·32	55	72·09	27	70·37	48	74·50	65	68·4
(*κ*) 100 *NB*/*NH*	77	51·08± ·32	25	50·03	166	50·07	58	49·36	27	55·43	70	48·70	78	50·7
(*λ*) 100 O_2/O_1; *L*	77	74·89± ·39	27*	86·00	169*	86·54	59	85·23	27	87·20	71*	84·5	80*	85·3
(*λ'*) 100 O_2/O_1; *R*	76	74·87± ·39												
(*μ*) 100 G_2/G_1 ...	67	71·94± ·61	—	—	133	88·51	47	85·02	25	81·52	47	74·4	72	72·1

* One eye only taken and which not stated.

† From measurements on Theban mummies of the Mook Collection at Munich.

FEMALE.

Character and Reference Letter	Naqada and allied Races								Unallied Races			
									Advanced		Primitive	
	Naqadas		Maciver's Prehistoric Egyptians		Theban Mummies		Modern Egyptians		'Altbayerisch' (Modern German)		Aino	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean	No.	Mean
(*a*) *C*	123	1287·9 ±5·4	—	—	74	1250·27	27	1213·96	100	1335·50	51	1308
(*b*) *F*	168	177·41± ·29	57	177·46	—	—	—	—	—	—	—	—
(*c*) *L*	185	177·47± ·28	58	177·90	77	174·81	27	171·41	—	173·45	62	177·2
(*d*) *L′*	159	177·89± ·29	—	—	—	—	—	—	—	—	62	176·2
(*e*) *B*	185	131·50± ·23	58	132·12	77	134·31	27	131·07	100	143·98	63	136·8
(*f*) *B′*	181	88·23± ·20	—	—	77	91·40	27	91·70	83	96·30	62	92·4
(*g*) *H*	169	129·47± ·25	49	128·33	77	130·51	27	130·30	96	128·01	62	135·1
(*h*) *OH* ...	174	113·11± ·20	—	—	76	109·75	26	109·27	100	114·17	63	115·0
(*i*) *LB*	141	94·86± ·25	45	97·64	76	95·29	26	96·00	90	95·80	60	100·3
(*j*) *U*	146	493·74± ·64	—	—	77	494·75	27	485·11	99	501·40	62	501·7
(*k*) *S*	151	363·64± ·70	—	—	76	357·93	27	352·00	90	353·40	53	360·7
(*l*) *Q*	151	296·49± ·46	—	—	77	296·21	27	295·63	97	318·70	61	317·1
(*m*) *GH* ...	27	109·92± ·74	—	—	72	107·43	12	104·00	—	—	21	112·1
(*n*) *G′H* ...	119	65·84± ·28	42	67·40	74	65·96	26	63·50	66	66·80	41	65·5
(*o*) *GB*	113	92·51± ·28	—	—	71	91·61	26	92·88	66	89·70	46	96·7
(*p*) *J*	63	117·04± ·47	42	119·55	77	121·22	26	120·62	67	126·30	44	129·7
(*q*) *NH* ...	123	46·73± ·19	46	47·67	74	48·36	26	45·31	72	48·20	46	47·4
(*r*) *NB*	119	24·31± ·11	46	23·86	72	24·21	26	24·62	72	23·70	45	24·7
(*s*) O_1L	118	41·70± ·14	*		*		*		*		*	
(*s′*) O_1R ...	113	41·30± ·14	46	37·22	73	37·04	26	36·85	79	38·32	49	39·8
(*t*) O_2L	117	32·16± ·13	*		*		*		*		*	
(*t′*) O_2R ...	116	31·87± ·14	46	32·22	75	32·25	26	32·50	79	33·18	50	33·9
(*u*) G_1	103	53·89± ·26	—	—	69	44·13	25	46·08	57	42·20	38	51·4
(*v*) G_2	103	38·87± ·22	—	—	69	38·67	25	39·04	55	32·10	46	37·4
(*w*) *GL*	106	91·02± ·30	45	93·69	74	91·93	26	94·96	—	—	43	100·1
(*x*) W_1	52	106·37± ·67	—	—	69	112·85	12	106·50	—	—	38	95·6
(*y*) W_2	59	87·62± ·55	—	—	70	89·2	12	86·75	—	—	—	—
(*z*) h_1	75	31·61± ·21	—	—	—	—	—	—	—	—	32	32·6
(*z′*) f	60	43·12± ·20	—	—	—	—	—	—	—	—	—	—
(*aa*) *P*∠ ...	89	84°·49± ·26	—	—	28	85°·57†	—	—	61	88°·8	41	81°
(*bb*) *A*∠ ...	93	72°·62± ·22	—	—	—	—	—	—	—	—	—	—
(*cc*) *N*∠ ...	93	66°·40± ·31	—	—	—	—	—	—	—	—	—	—
(*dd*) *B*∠ ...	93	40°·98± ·19	—	—	—	—	—	—	—	—	—	—
(*ee*) θ_1	89	29°·09± ·25	—	—	—	—	—	—	—	—	—	—
(*ff*) θ_2	89	11°·82± ·26	—	—	—	—	—	—	—	—	—	—
(*α*) 100 *B*/*L′* ...	146	73·86± ·16	—	—	—	—	—	—	—	—	—	—
(*β*) 100 *B*/*L* ...	169	74·19± ·16	58	74·27	77	76·53	27	76·61	100	83·10	62	77·6
(*γ*) 100 *H*/*L′* ...	141	73·11± ·16	—	—	—	—	—	—	—	—	—	—
(*δ*) 100 *H*/*L* ...	166	73·22± ·16	49	72·14	77	74·69	27	76·09	96	73·90	61	76·7
(*ε*) 100 *H*/*B* ...	169	98·66± ·25	49	97·13	77	97·26	27	99·50	—	—	—	—
(*ζ*) 100 *B*/*H* ...	163	101·59± ·25	49	102·96	77	102·81	27	100·50	96	88·80	62	98·8
(*η*) 100 *GH*/*GB*	22	118·87± ·97	—	—	71	112·75	12	113·43	—	—	21	115·9
(*θ*) 100 *G′H*/*GB*	106	70·36± ·27	—	—	71	72·27	26	68·54	58	74·40	60	67·7
(*κ*) 100 *NB*/*NH*	113	52·31± ·31	46	50·14	72	50·23	26	54·58	72	49·20	44	50·5
(λ) 100 O_2/O_1; *L*	111	76·91± ·29	*		*		*		*		*	
(λ′) 100 O_2/O_1; *R*	113	77·32± ·48	46	87·04	73	89·81	26	87·69	79	86·60	48	85·2
(*μ*) 100 G_2/G_1 ...	97	72·30± ·41	—	—	60	88·34	24	84·40	51	76·00	38	72·8

* One eye only taken and which not stated.

† From measurements on Theban mummies of the Mook Collection at Munich.

of Africa. They were copied from the MSS. of Broca in Paris for Professor Pearson through the courtesy of M. Manouvrier.

To these allied races the data for two other races have been added.

(*e*) Ranke's measurements on "Altbayerisch" skulls from his *Beiträge zur physischen Anthropologie der Bayern*, Bd. I.

(*f*) Koganei's measurements on Aino skulls. *Beiträge zur physischen Anthropologie der Aino, Mitteilungen aus der medicinischen Facultät der k. j. Universität.* Tokio, 1894, Bd. II.

We are thus able to compare the Naqadas with both a highly civilised modern race and an extremely primitive type.

TABLE VI.

Modern Negroes *.

Character and Reference Letter	Male		Female	
	No.	Mean	No.	Mean
(*a*) *C* ...	54	1430	23	1256
(*c*) *L* ...	54	185·04	23	174·52
(*e*) *B* ...	54	135·20	23	130·52
(*g*) *H* ...	54	134·77	23	126·91
(*β*) 100*B*/*L*	54	73·28	23	74·85
(*δ*) 100*H*/*L*	54	72·83	23	72·75

Before we discuss the bearing of these tables we must refer to one or two matters with regard to the general measurement of cranial characters. It must first be observed that it is extremely difficult to fix a conventional measurement by a printed statement. The skull is not a system of geometrical points, and a personal view as to what is to be taken as the "point" may quite well bias one way or the other a measurement by one or more millimetres. For example in measurements made from the German horizontal plane, one investigator may take it from the auricular axis and the left eye, another from the right eye and a third from what he considers the mean of the two. These differences will easily lead to as much as 1° difference in its position. Thus the personal equation is far more important in the measurement of some characters than the errors of random sampling, even though our samples are small. We cannot safely conclude as to racial difference from differences greater than those of random sampling, when we are treating certain organs of which the measurement is difficult of exact definition.

* From Broca's MSS. measurements at Paris. Chiefly but not entirely from Algiers, the Soudan and the West Coast of Africa. The capacities are as in the case of all Broca's measurements exaggerated. If we modify them by the reduction suggested in *Archiv f. Anthropologie*, Bd. XIII. Suppl. S. 78 we find Negro ♂ =1347, ♀ =1175, values much nearer to those given in Table V. for the modern Negro.

One of the worst of such measurements is the palate length G_1. According to the original version of the Frankfurt Concordat this was to be measured from the point of the spine to the inner-wall of the alveolar rim between the middle incisors. This is the measurement we attempted to make. We believe it is also the measurement attempted by Koganei on the Aino. Now the spine has frequently been broken or worn away and accordingly the measurement cannot always be made. Hence the Germans have begun to take the palate length from the *base* of the spine, which is not in agreement with their own Concordat. Further, what is "the inner wall of the alveolar rim between the middle incisors"? The inner wall runs in and almost encircles the teeth and its fine edge is very generally broken in on ancient skulls. Accordingly "the inner wall between the middle incisors" has recently come to be taken as the mid-point of a line tangential to the tops of the inner wall on the two incisors*. An examination of the bases of the skulls in our photographs will show what a great difference this interpretation of the original Concordat makes. The major part of the divergence of G_1 for Naqada from G_1 for the Theban Mummies and modern Egyptians is solely due to this change of convention and not to racial differences.

Dr W. R. Macdonell has kindly made a series of measurements on this point. First he has dealt with the length of spine and finds the following results:

TABLE VII.

Length of Spina nasalis posterior.

English Skulls			Naqada Skulls		
Number	Sex	Mean	Number	Sex	Mean
19	♂	3·55 mm.	20	♂	5·05 mm.
17	♀	3·19 mm.	18	♀	4·00 mm.

There is thus a very sensible difference between the length of spine in English and prehistoric Egyptian skulls, and further the omission or inclusion of the spine is a matter in the average of 3 to 5 mm. difference in the measurements. In the next place Dr Macdonell undertook a series of measurements (*a*) from the tip of the spine to the inner wall of the alveolar margin between the middle incisors and (*b*) from the tip of the spine to the niveau of the inner alveolar margin on the middle incisors.

* See E. Schmidt: *Anthropologische Methoden*, S. 238. He takes, however, the "Basis dieser Spina nasalis posterior" to be the direction for measurement of the Frankfurt Concordat, which is precisely opposite to the "Spitze der Spina" in the printed versions of the Concordat kindly provided by Professor Ranke. Further Dr Schmidt prints *Basis* for the original *Spitze* in the version of the Concordat he gives in an appendix without commenting on the change.

He found for the Naqada skulls:

Mean difference 20 ♂ skulls 4·87 mm.
„ „ 18 ♀ „ 4·02 mm.

Hence for the Naqada skulls we have the following results:

Mean reduction in length of palate due to measuring by E. Schmidt's convention instead of in strict accordance with the wording of the Frankfurt Concordat

= 9·92 mm. for males, and = 8·02 mm. for females.

Hence to compare our measurements on the Naqada skulls with Schmidt's on the Theban Mummies, with those on the modern Egyptians and probably with those on the Negroes, we must subtract the above quantities from the mean values of G_1 in Table V. We find:

TABLE VIII.

Palate Measurements on Naqada Skulls.

	Length of Palate (G_1)	Palate Index ($100G_2/G_1$)
♂	45·88	87·90
♀	45·87	84·74

Comparing these results with those given in the table it will be seen: first, that the chief sexual difference in the Naqada skulls depends upon the length of spine; and secondly, that the palate measurement no longer forms a character by which we can definitely distinguish between prehistoric and historic Egyptians. For, the breadths of the palate are sensibly the same in both sexes for Naqadas, Thebans and Copts. In the lengths we have for males: Naqadas 46, Thebans 46, Copts 47, and for females: Naqadas 46, Thebans 44, Copts 46. No weight can safely, considering the numbers dealt with, be put on these somewhat irregular slight differences, nor on the resulting differences in the palate index.

Another very questionable measurement is the breadth of the orbit O_1. The Frankfurt Concordat runs: "Von der Mitte des medialen Randes der Augenhöhle bis zum lateralen Rand der Augenhöhle." This reads as if the medial rim were a perfectly definite margin which is very rarely the case. E. Schmidt has got over the difficulty by taking a more or less definite point for the nasal end of the measurement. He writes: "Als Maasspunkt am inneren Rande ist die Stelle zu wählen, wo die hintere Kante der Thränengrube oben mit Stirn-Thränenbeinnaht zusammentrifft (*Point lacrymal* der französischen Schule)."*

This is fairly, but not universally definite. But it by no means necessarily gives the "grösste Breite des Augenhöhleneinganges," whatever that may be, of the Frankfurt Concordat.

* *Anthropologische Methoden*, S. 236.

Ranke admits* the difficulty as to the position of the callipers point on the nasal side and draws: "eine Verbindungslinie zwischen den stets deutlichen inneren Ausläufern des oberen und unteren Augenhöhlenrandes." He further states that "über den wahren Verlauf dieser Verbindungslinie kann ein ernsthafter Zweifel niemals bestehen." Unfortunately with the experience of the Naqada skulls before us, we cannot fully agree in this opinion. Is the "Verbindungslinie" to be a geodesic between the last sensible points of the upper and lower orbital rims, or is it to be a curve on the nasal wall following the general curvature indicated by the sweep of the orbital rims? The difference in the breadth of the orbit with one or other of these interpretations will frequently amount to several millimetres. Ranke probably had one or other of these ideas clearly in his mind—he does not say which—and so passed over the other. Intermediate stages between the two are possible and thus the personal equation again looms largely in the background. In our measurements an attempt was made to follow the curvature of the rim, and not to form a geodesic. The result is that the breadth of the Naqada orbit comes out larger and the orbital index less than those of the Thebans or Copts which were measured probably by Schmidt's convention.

Dr W. R. Macdonell kindly measured 40 ♂ orbits and 30 ♀ orbits for the Naqadas by what we may term the 'geodesic' method for comparison with those obtained by the 'curvature' method. The results show: first, that the difference is in both sexes greater for the left than for the right eye; secondly, it averaged about 1·9 mm. for male and 1·6 mm. for female eyes. Taking the average of both orbits, this would reduce our measurements as follows:—

Maximum Breadth of Naqada Orbit O_1.

♂ 40·8 mm. ♀ 39·9 mm.

These are practically identical with the values given by Koganei for the Aino, but still differ sensibly from the values for the Thebans and Copts. There is no doubt, however, that these were measured from the "lacrymal point." Maciver does not tell us how he measured the breadth of his orbits, but just as our measurements for the height of the Naqada orbit agree perfectly with his, and with those for Thebans and Copts, his for the breadth are also in perfect agreement with those for Thebans and Copts. We think we may therefore conclude that so far from there existing any sensible distinction between the shape or size of the orbit between prehistoric and historic Egyptians, there really is absolute identity if the orbit be measured in the same manner.

We are now in a better position to look through Table V. and compare our allied races. We turn first to the Naqada of 6000 B.C., the Thebans of 1500 B.C. and the Copts of to-day, three races dividing an interval of about 7000 to 8000 years into two periods of 3000 to 4000 years. It is impossible not to be impressed at once with the striking likenesses between these three groups, especially when we notice how small are the number of skulls upon which occasionally (as for

* *Beiträge zur physischen Anthropologie der Bayern*, Bd. 1. *Die Bildung der Augenhöhlen*, S. 94.

modern ♀ Copts) the means are based. Compare for example the ♂ Naqadas in capacity (*C*), horizontal circumference (*U*), sagittal circumference (*S*), vertical circumference (*Q*), breadth of face (*GB*), nasal height (*NH*), nasal breadth (*NB*), orbital breadth* (O_1), orbital height (O_2), palate length (G_1)†, palate breadth (G_2), profile length (*GL*), profile angle (*P*), height-breadth index (100 *H*/*B*), nasal index (100 *NB*/*NH*), orbital index (100 O_2/O_1), and palate index (100 G_2/G_1), with the like quantities for the Thebans, and it seems impossible to hold that we are dealing with really different races or even with a mixture of races. Evidence in the same direction if less definite may be drawn from the auricular height (*OH*), the skull-base (*LB*), the height-breadth index (*H*/*B*) and having regard to Maciver's measurements and those on the Copts, the zygomatic breadth (*J*).

Turning to the females we reach much the same results; in several cases where the Naqada appear to differ slightly from the Thebans, they are seen to be intermediate between the latter and the Copts or Maciver's measurements show us how a slight difference in sample or method of measurement brings Naqadas into line with Thebans or Copts or both. The Germans and Aino, and in many cases the Negroes show us how widely divergent different races can be from a group like the Naqada-Theban-Copt series. Compare for example the Germans and Aino with the Egyptian group in ♂ skull circumferences (*U*, *S*, *Q*) and the Negroes and the Egyptian group in nasal breadth, orbital height, length of profile, or palate index. In some respects, indeed, the *modern* Negro is closer to the later Egyptians, Thebans or Copts, than to the Naqadas. He stands on the whole nearer to the Egyptian group than to races like the German or Aino, but it seems impossible to assert that he is closer to the Naqadas than to the later Egyptians. If the historic Egyptians are to be treated as distinct from the Negroes, then certainly the Naqadas are. Skulls of a negroid type may be found among our material, and possibly competent type-craniologists would have cast them out at once, but our general averages are quite sufficient to show that we are dealing with distinct races, and one which 6000 or 7000 years ago was as distinct from the Negro as it is to-day.

If we accept the general proposition that the Naqadas, Thebans and Copts are for a number of characters so closely related that we are bound to consider them as in bulk the *same* stock, we are still forced to the conclusion that in certain characters a progressive evolution has taken place, for these characters have substantially changed. If it be asserted that the change is due to racial mixture, then the fact that other characters have remained practically stationary is very difficult of interpretation, for the result of mixture would be to alter these also. On the other hand, the comparatively small correlations of the parts of the skull‡ show that if certain characters in the skull be modified by selection, the change in other characters need not be significant, if the latter have not themselves been directly selected. The most noteworthy of these changing characters are the

* See remarks, p. 431. † See remarks, p. 430.

‡ See the section on correlation below.

decreasing length (L), the increasing breadth (B), the increasing frontal breadth (B'), the increasing auricular height (OH) and the increasing total facial height (GH) for the males. For the females the Copt crania are so few in number that they are scarcely of value for comparative purposes. Still the main changes—decrease in length and increase in breadth—are well marked between Naqadas and Thebans. These changes appear again in the progressively increasing values of the two indices B/L and H/L.

The following table shows the most significant changes and places for comparison alongside them changes that have gone on within England itself. From these results, we think, it must be concluded that the changes between prehistoric, historic and modern Egyptians, even when they are greatest, are not greater than we find between different classes of the same community, or between members of the same community at a few centuries interval. We are not therefore compelled to assume that admixture of races to which the "fixed-type" craniologist is always appealing. The supposition of an intraracial evolution, tending in both Egyptian and English cases in the same direction—conveniently if not quite exactly described as towards increased brachycephaly—is the most reasonable view of the facts.

TABLE IX.

*Male Crania.**

Character	Naqadas	Thebans	Copts	17th Century English	Modern English	
					Criminal	Upper Class
Capacity ...	1381	1388	1355	1522	[1378]†	[1431]†
Length ...	185·13	181·94	179·11	187·65	180·44	182·51
Breadth ...	134·87	136·63	136·51	140·00	139·30	142·96
Cephalic Index	72·99	75·07	77·30	74·73	77·23	78·33

But if changes in the mean length of the skull of 3 to 7 mm., in the mean breadth of the skull of 2 to 3 mm. and in the cephalic index of 3 to 4 points can arise in periods of 300 to 6000 years, it seems possible that a period of 100,000 years with evolution working only at the same rate would suffice to have modified the skull from a form which the craniologist would hesitate to term human. In other words the pace of evolution may be far greater than has hitherto been suggested. The problem of the evolutionist is not to show that at all times all characters in all species are rapidly changing, but that at some times some species are changing at a rate which on the whole would suffice to bring the biological record into synchronism with geological limits.

* Measurements on Prof. Thane's 17th century skulls by A. Martin Leake and G. U. Yule. For the modern English: see Macdonell, *Biometrika*, Vol. I. p. 190.

† Deduced from Dr A. Lee's formula, *Phil. Trans.* Vol. 196, A, p. 252.

We may turn now to the actual means for the Naqada race and give these numbers their classes according to the conventions of the *Frankfurter Verständigung.*

TABLE X.

Specification of Naqada Race.

Character	Class ♂	Class ♀	Remarks
(β) $100B/L$	Dolichocephaly ...	ditto	Female significantly less dolichocephalic
(γ) $100H/L$	Orthocephaly ...	ditto	Sexes equally orthocephalic
($\alpha\alpha$) Profile Angle	Mesognathy ...	Mesognathy	Sexes alike
(η) Facial Index	Narrow faced ...	ditto	Sexes practically alike
(θ) Upper Face Index ...	Narrow upper face	ditto	Sexes alike
Zygom. Face Index* ...	Chamaeprosopy ...	Leptoprosopy	♂ index = 89·17 ; ♀ index = 93·92†
Zygom. Upper Face Index*	Leptoprosopy ...	Leptoprosopy	♂ index = 53·80 ; ♀ index = 56·25‡
(λ) Orbital Index	Chamaeconchy ...	Chamaeconchy	Actual Frankfurt Concordat results as in Table V. Female sensibly less so than male
ditto	Hypsiconchy ...	Hypsiconchy	Maciver-Schmidt method of measurement. Female differs sensibly from male
(κ) Nasal Index	Platyrrhiny ...	Platyrrhiny	The male is on the borders of mesorrhiny and differs sensibly from female
(μ) Palate Index	Leptostaphyline ...	Leptostaphyline	Actual Frankfurt Concordat results as in Table V. Sexes alike
ditto	Brachystaphyline ...	Mesostaphyline	Schmidt's convention as in Table, p. 430. Sexes sensibly different
Alveolar Index*§ ...	95·35	95·95	Sexes practically alike

We are dealing therefore with a long-headed narrow-faced race with a flat nose and rather round orbits. Comparing the sexes we note that male and female are significantly different in cephalic and zygomatic face indices, further in the shapes of the orbit and of the nose; or greater tendencies to brachycephaly, leptoprosopy, hypsiconchy, and platyrrhiny seem secondary sexual characters in the female. These results receive confirmation from a sexual comparison of the

* A formula for calculating the index from the means of the lengths is given by Pearson: *R. S. Proc.* Vol. LX. p. 492, but the corrective terms modifying the simple ratio of the means are insensible to two places of decimals in the present cases.

† For Ainos zygomatic face index for ♂ = 86·2, for ♀ = 86·4.

‡ For "Altbayerisch" skulls zygomatic upper face index for ♂ = 52·4, for ♀ = 52·8, and for Ainos for ♂ = 50·8, for ♀ = 50·5.

§ The alveolar index, $= 100GL/LB$, is not considered and classified in the *Frankfurter Verständigung*, so the actual values are here given.

Q. 392

T. 10^{B}

T. 29^{A}

Q. 392

T. 10^{B}

T. 29^{A}

Q. 392

T. 10^{B}

T. 29^{A}

MALE NAQADA CRANIA.

Q. 758

530

1755

Q. 758

530

1755

Q. 392

T. 10[B]

T. 10[B]

MALE NAQADA CRANIA.

1308

Q. 326 Lower

1308

Q. 326 Lower

R. 2

Q. 326 Lower

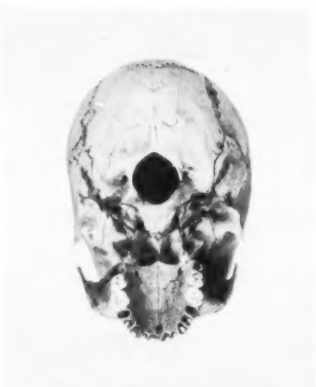
R. 2

FEMALE NAQADA CRANIA.

Q. 408[D]

R. 2

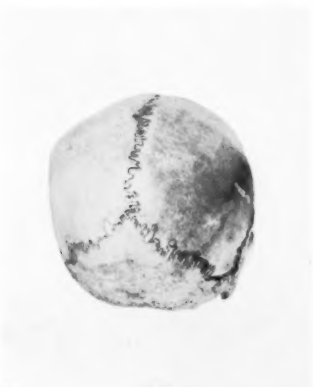
Q. 326 Lower



Q. 408[D]

R. 2

Q. 408[D]



R. 2

FEMALE NAQADA CRANIA.

1644

Q. 791

1300

1377

R. 5

Q. 383

Q. 359[2]

1446

ABNORMAL AND SPECIAL NAQADA CRANIA.

1587[4]

Q. 18

1031

B. 83

1587[1]

1587[4]

Q. 513

T. 5[F]

Plate X.

ABNORMAL AND SPECIAL NAQADA CRANIA.

same characters in the other Egyptian series. Comparing the German measurements we do not find any sensible sexual differences in head, face or nose indices, but there are such differences in the orbital and palate indices and in the same directions as in the Egyptian series. In the Ainos it is only in brachycephaly that the women show sensible difference from the men. Hence we cannot assert that the secondary sexual characters of one race are those of all races.

The platyrrhine character of the nose and the leptostaphyline form of the upper jaw together with the values for the auricular height (OH) and the cross-circumference (Q) seem not entirely consonant with what Professor Petrie tells us of the portraiture* (see p. 412 above). It is possible that this portraiture was to some extent conventional, or that it in fact gives some other type than the Naqada. Still the crania agree with the portraiture in not giving a markedly primitive type. There is no trace of "neanderthaloid" skulls in the collection. This is more or less confirmed by the probable Naqada stature, which is well above that of continental neolithic or palaeolithic man, above the French and South German commonality of to-day, just above the English criminal classes and only 2 to 3 cms. below the upper-class English. Its nearest equivalent is the modern Nubian†. There is nothing, whatever, which would lead us to believe that we are dealing with a markedly primitive type, although occasionally primitive characteristics, such as a markedly curved dental arch or strongly emphasised upper temporal lines, may be found among the material. A very fair notion of the cranial characters in general may be obtained from Plates V—VI, which give typical male skulls, Plates VII—VIII which give typical female skulls and Plates IX—X which reproduce special features of anatomical or pathological interest‡.

These plates, together with the measurements, will enable the reader to confirm the views above expressed, i.e. (i) that the Naqadas are not a race of markedly primitive character, (ii) nor very much nearer to the Negro than the historic Egyptians or the Copts of to-day. It will need a far more comprehensive study of modern and ancient Negro crania than has yet been made to see in its due proportions this Negro and Egyptian relationship. Meanwhile our study of the skulls seems to be in complete agreement with Dr Warren's conclusions as drawn from the long bones:

"Here then in the New Race we have a hardy and vigorous people, as shewn by the pronounced pilastre of the femur and the platycnemia of the tibia. Just as is observed in so many races, in

* Prof. Petrie's description of the portraiture undoubtedly seems to refer to a race differing far more from the historic Egyptians than the cranial measurements of the Naqadas appear to allow for.

† Pearson: *Phil. Trans.* Vol. 192, A, pp. 211 and 243.

‡ We owe the photographs from which these plates were prepared to the patience and care of Mr D. Radford Sharpe, to whom our most hearty thanks are due. The skulls were placed on cups on a horizontal table and the camera vertically above them, and sensibly at the same distance from them all. To avoid increasing the very heavy labour—in the dull weather in which it was necessary to carry out the work, some exposures required upwards of 30 minutes—two and sometimes three skulls were taken on the same plate. This will suffice to explain why the adjustment in some pairs seems at fault—the right and left-hand skulls, even if placed truly horizontal, were seen from rather different relative standpoints.

some characters the New Race was advanced or modern; in others it was inferior or primitive. On the whole, the proportions of the limb-bones to one another may be said to have approached those of the Negro, while the sacral and scapular indices were almost identical with those of Europeans*."

In total height and auricular height of skull, in height and breadth of face, in nasal height, in cephalic index and upper face index the Naqadas approached the modern Negro. But in nasal breadth, height of orbit, palate length and nasal index they are closer to the Germans. In length of skull, sagittal circumference, facial index, breadth-height ratio and nasal index they are, perhaps, closest to a primitive race like the Aino. Thus the cranial results fully bear out the judgment from the long bones, that the race was in some characters advanced or modern, in others inferior or primitive.

(8) *General points.*

Of other points to which attention may be drawn in our general table of means we note:

(*a*) The mean male skull with the possible exception of the breadth of the orbit is significantly larger than the mean female skull.

(*b*) While the height of the male skull appears to be significantly greater than the breadth, that of the female seems significantly less. (Cf. (ϵ) and (ζ) in Tables V^a and V^b.)

(*c*) The left orbit for both measurements in both sexes appears larger than the right orbit. Thus the orbit gives the advantage to the left, which agrees with the predominating side of the skeleton found by Dr Warren in the case of femur, tibia and fibula, whereas in the case of humerus, radius and ulna the right-hand side was the larger†.

(*d*) The advantages of measuring Flower's length, the maximum length, and the horizontal length (F, L and L'), are seen to be remarkably small. When the sample numbers as many as 160 to 200 skulls—a number very rarely reached in craniological investigations, the differences between F, L and L' are not beyond the limits of random sampling for female skulls, and the difference between F and L' scarcely beyond these limits for male skulls‡. The indices calculated for L and for L' are sensibly identical within the limits of random sampling, and it is accordingly for all purposes of racial comparison and relationship not worth the labour to measure these three lengths separately. One or other may be from the anatomical standpoint a better measurement to make, but the craniologist who knows either F,

* *Phil. Trans.* Vol. 189, B, p. 191. An Investigation of the Variability of the Human Skeleton with special reference to the Naqada Race.

† *Phil. Trans.* Vol. 189, B, pp. 159 *et seq.* The right is the larger side also in the case of the hand: see Whiteley and Pearson, *R. S. Proc.* Vol. 65. p. 129 and Lewenz and Whiteley, *Biometrika*, Vol. 1. p. 348.

‡ The results would probably have been still closer, if the means had been struck for the same skulls.

L or L' knows the other two for his population as far as the errors of random sampling allow him to trust his measurements*. Of course the result might be different could we deal with 500 to 1000 crania of one sex and race, but there is small hope of such numbers in the majority of cases. It is inexpedient, while there is so much to be done, to multiply measurements which differ by quantities of the order of the probable error of their determination†.

(9) *On the Variability of the Naqada Race.*

Before we consider the actual frequency distributions and the graphical graduations of some of the more important characters, it may be well to examine the numerical values of the variations as a whole. These are given with the probable errors in Table XI.

We have here for the first time a moderately extensive table of the variability of the characters of the human skull, and further the probable errors are given in each case so that the significant differences can be discriminated. The misfortune is that there is so little material available for comparative racial purposes. Only one or two organs have so far had their variability measured for anything like a long series of races. The capacity of the skull has been fairly completely dealt with by Pearson‡. We extract the following coefficients of variation for comparison:

	♂	♀		♂	♀
17th Century English	7·68	8·15	Etruscans	9·58	8·54
Parisian French	7·36	7·10	Egyptian Mummies	8·13	8·29
Italians	8·34	8·99	Naqadas	7·72	6·92
Germans	7·74	8·19	Negroes	7·07	6·90
Ainos	6·89	6·82	Modern Egyptians	8·59	7·17
Low Caste Panjabis	7·24	8·99			
Polynesians	8·20	5·55			
Kanakas	7·37	6·68			
Andamanese	5·04	5·59			

It will be seen at once that the Naqadas show no exceptional variability, but have their men and women somewhat less equal in variability than is the case with the Egyptian mummies or the Negroes. The Naqada values lie between those of the Negroes and those of the Egyptians but they are not, except in the case of the women to the negresses, really close to either.

* This point had been already demonstrated for the cephalic index, see Pearson: *The Chances of Death*, Vol. I. p. 270 footnote.

† Thus although L should generally be greater than L' and $100\,B/L$, $100\,H/L$ less than $100\,B/L'$, and $100\,H/L'$, still the difference of the samples on which L or L' are taken is quite sufficient in itself to upset such relations. Of course it is only possible to get L' when both auricular passages and one or other eye-socket remain perfect; thus we can usually find L for more skulls than L'. I should therefore be inclined to suggest that F and L' should be dropped in future systems of measurement.

‡ *The Chances of Death*, Vol. I, pp. 328—349. The short series of Naqada skulls given on p. 339 of that work must now be replaced by the complete series given in this paper.

TABLE XI.

Variability of the Naqada Race.

Character	Male			Female		
	Mean	Standard Deviation	Coefficient of Variation	Mean	Standard Deviation	Coefficient of Variation
C	1380·99 ± 7·67	106·68 ± 5·42	7·72 ± ·39	1287·91 ± 5·42	89·18 ± 3·84	6·92 ± ·30
F	183·96 ± ·37	6·03 ± ·26	3·28 ± ·14	177·41 ± ·29	5·59 ± ·21	3·15 ± ·12
L'	184·87 ± ·37	5·99 ± ·26	3·24 ± ·14	177·89 ± ·29	5·51 ± ·21	3·10 ± ·12
L	185·13 ± ·33	5·75 ± ·23	3·17 ± ·13	177·47 ± ·28	5·57 ± 20	3·14 ± ·11
B	134·87 ± ·26	4·60 ± ·19	3·29 ± ·13	131·50 ± ·23	4·55 ± ·16	3·45 ± ·12
B'	91·06 ± ·27	4·82 ± ·19	5·29 ± ·21	88·23 ± ·20	3·94 ± ·14	4·47 ± ·16
H	135·21 ± ·31	5·38 ± ·22	3·98 ± ·16	129·47 ± ·25	4·74 ± ·17	3·66 ± ·13
OH ...	115·59 ± ·25	4·46 ± ·18	3·86 ± ·16	113·11 ± ·20	4·00 ± ·14	3·54 ± ·13
LB ...	99·34 ± ·31	4·85 ± ·22	4·88 ± ·22	94·86 ± ·25	4·44 ± ·18	4·68 ± ·19
U	511·02 ± ·81	13·00 ± ·57	2·54 ± ·11	493·74 ± ·64	11·47 ± ·46	2·27 ± ·09
S	373·02 ± ·74	11·91 ± ·52	3·19 ± ·14	363·64 ± ·70	12·77 ± ·50	3·51 ± ·14
Q	304·22 ± ·63	10·11 ± ·45	3·32 ± ·15	296·49 ± ·46	8·07 ± ·33	2·72 ± ·11
GH ...	112·02 ± ·76	5·97 ± ·54	5·33 ± ·48	109·92 ± ·74	5·68 ± ·52	5·17 ± ·18
$G'H$ ...	67·59 ± ·30	4·11 ± ·21	6·08 ± ·31	65·84 ± ·28	4·47 ± ·20	6·87 ± ·30
GB ...	95·85 ± ·37	4·97 ± ·26	5·18 ± ·27	92·51 ± ·28	4·41 ± ·20	4·77 ± ·21
J	125·63 ± ·48	5·22 ± ·34	4·16 ± ·27	117·04 ± ·47	5·58 ± ·34	4·77 ± ·29
NH ...	48·94 ± ·21	3·00 ± ·15	6·13 ± ·31	46·73 ± ·19	3·18 ± ·14	6·81 ± ·29
NB ...	25·12 ± ·14	1·98 ± ·10	7·89 ± ·41	24·31 ± ·11	1·80 ± ·08	7·28 ± ·32
O_1L ...	43·11 ± ·16	2·14 ± ·11	4·97 ± ·26	41·70 ± ·14	2·21 ± ·10	5·30 ± ·24
O_1R ...	42·60 ± ·16	2·14 ± ·11	5·02 ± ·27	41·30 ± ·14	2·22 ± ·10	5·38 ± ·24
O_2L ...	32·67 ± ·17	2·31 ± ·12	7·06 ± ·38	32·16 ± ·13	2·12 ± ·09	6·58 ± ·29
O_2R ...	31·87 ± ·18	2·32 ± ·13	7·27 ± ·41	31·87 ± ·14	2·18 ± ·10	6·85 ± ·38
G_1 ...	55·80 ± ·28	3·62 ± ·20	6·49 ± ·36	53·69 ± ·26	3·98 ± ·19	7·41 ± ·35
G_2	40·33 ± ·29	3·75 ± ·21	9·29 ± ·51	38·87 ± ·22	3·32 ± ·16	8·55 ± ·40
GL ...	94·72 ± ·34	4·58 ± ·44	4·84 ± ·26	91·02 ± ·30	4·63 ± ·21	5·09 ± ·24
W_1 ...	110·49 ± ·87	8·24 ± ·61	7·46 ± ·56	106·37 ± ·67	7·20 ± ·48	6·77 ± ·45
W_2 ...	93·58 ± ·67	7·13 ± ·48	7·62 ± ·51	87·62 ± ·55	6·30 ± ·39	7·19 ± ·45
h_1	32·91 ± ·28	3·27 ± ·20	9·93 ± ·62	31·61 ± ·21	2·68 ± ·15	8·47 ± ·47
f	44·44 ± ·25	2·55 ± ·17	5·73 ± ·39	43·12 ± ·20	2·29 ± ·14	5·31 ± ·33
$P\angle$	84°·41 ± ·25	2°·87 ± ·17	—	84°·49 ± ·26	3°·66 ± ·18	—
$A\angle$ ...	72°·81 ± ·33	4°·16 ± ·23	—	72°·62 ± ·22	3°·14 ± ·16	—
$N\angle$ ...	66°·60 ± ·30	3°·77 ± ·21	—	66°·40 ± ·31	4°·48 ± ·22	—
$B\angle$ ...	40°·73 ± ·22	2°·80 ± ·16	—	40°·98 ± ·19	2°·76 ± ·14	—
θ_1	28°·98 ± ·29	3°·34 ± ·20	—	29°·09 ± ·25	3°·44 ± ·17	—
θ_2	11°·30 ± ·34	3°·92 ± ·24	—	11°·82 ± ·26	3°·65 ± ·18	—
$100B/L'$ ...	72·70 ± ·19	2·88 ± ·13	3·96 ± ·18	73·86 ± ·16	2·89 ± ·11	3·92 ± ·12
$100B/L$ ...	72·99 ± ·17	2·80 ± ·12	3·83 ± ·16	74·19 ± ·16	3·12 ± ·11	4·20 ± ·11
$100H/L'$ ...	73·20 ± ·18	2·77 ± ·13	3·85 ± ·17	73·11 ± ·16	2·81 ± ·11	3·85 ± ·15
$100H/L$ ...	73·30 ± ·16	2·73 ± ·11	3·73 ± ·16	73·22 ± ·16	2·96 ± ·11	4·04 ± ·15
$100H/B$ ...	100·47 ± ·28	4·73 ± ·20	4·72 ± ·20	98·66 ± ·25	4·66 ± ·17	4·73 ± ·18
$100B/H$ ...	99·76 ± ·27	4·53 ± ·19	4·54 ± ·19	101·59 ± ·25	4·74 ± ·18	4·66 ± ·18
$100GH/GB$	117·06 ± ·72	5·30 ± ·51	4·53 ± ·43	118·87 ± ·97	6·73 ± ·68	5·67 ± ·58
$100G'H/GB$	70·63 ± ·35	4·52 ± ·25	6·41 ± ·35	70·36 ± ·27	4·15 ± ·19	5·91 ± ·27
$100NB/NH$	51·08 ± ·32	4·18 ± ·23	8·18 ± ·44	52·31 ± ·31	4·86 ± ·22	9·28 ± ·42
$100O_2/O_1$: L	74·89 ± ·39	5·06 ± ·27	6·76 ± ·37	76·91 ± ·29	4·57 ± ·21	5·94 ± ·27
$100O_2/O_1$: R	74·87 ± ·39	5·00 ± ·27	6·68 ± ·36	77·32 ± ·48	4·78 ± ·21	6·18 ± ·28
$100G_2/G_1$ ...	71·94 ± ·61	7·36 ± ·43	10·23 ± ·60	72·30 ± ·41	5·93 ± ·29	8·20 ± ·40

If we turn to the length, breadth, and height of the skull, our data for comparison are still more sparse. We find:

Race.	Length.		Breadth.		Auricular Height.	
	♂	♀	♂	♀	♂	♀
Bavarian*	3·37	3·57	3·89	3·39	4·47	3·91
English†	3·44	3·66	3·55	3·78	—	—
French‡	3·97	3·65	4·21	3·67	—	—
Naqada	3·17	3·14	3·29	3·45	3·86	3·54
Aino*	3·20	3·08	2·76	2·68	3·67	3·18

Again the Naqada lie between the 'primitive' Aino and the high modern civilisations.

Of circumferential measurements we can only compare:

Race.	Horizontal Circumference.		Vertical Circumference.	
	♂	♀	♂	♀
Bavarian§	2·86	3·09	—	—
Ancient Egyptian‖	2·74	2·85	2·67	2·84
Naqada	2·54	2·27	3·32	2·72
Row Grave German§	2·70	2·40	—	—

This table shows us much the same state of affairs, and we mark as usual the advance in variability with advancing civilisation. Only one other absolute dimension¶ are we able to give a comparison with; namely the length of the palate. We have:

Race.	Length of Palate.	
	♂	♀
Bavarian	6·42	6·85
Naqada	6·49	7·41

Thus Bavarian and Naqada data both agree in making the woman more variable in palate length than the man. All the above are comparisons of coefficients of variation.

For angular measurements we can only quote the variability in profile angle of the Bavarians:

Race.	Standard Deviation.	
	♂	♀
Bavarian	2°·79	3°·59
Naqada	2°·87	3°·66

* Dr Alice Lee: *Phil. Trans.* Vol. 196, A, p. 230.

† Unpublished data for the Whitechapel skulls deduced by Prof. Pearson.

‡ Unpublished reductions of measurements in Broca's manuscripts by C. D. Fawcett.

§ Pearson: *The Chances of Death*, Vol. I. pp. 356–7.

‖ Deduced from Dr Alice Lee's data. *Phil. Trans.* Vol. 196, A, p. 262.

¶ Raw material enough is of course available, but the object of this present memoir is rather to show how craniological results are to be presented from the statistical side than to publish long reductions of other investigators' measurements.

In the case of both races for palate and profile the females are markedly more variable than the males. Further the ancient is here more variable than the modern race.

Lastly we turn to the indices. Here somewhat more material is available; we give now the standard deviations:

Race.	*B/L*		*H/L*		*H/B*	
	♂	♀	♂	♀	♂	♀
Bavarian*	3·50	2·97	—	—	—	—
English†	3·31	3·37	—	—	—	—
French‡	4·43	4·19	3·53	3·67	4·74	4·31
Naqada	2·80	3·12	2·73	2·96	4·73	4·66
Egyptian Mummies*	3·35	3·36	—	—	—	—
Modern Egyptians*	5·42	5·10	—	—	—	—
Negroes§	2·77	3·52	—	—	—	—
Panjabi Low Caste§	2·98	3·75	—	—	—	—
Aino§	2·41	2·54	—	—	—	—
Row Grave Germans§	2·28	2·35	—	—	—	—

Clearly the Naqada race has less variability than that of the highly advanced modern races, but as much or more than 'primitive' peoples like the Aino and Row Grave Germans. The very wide-spread evidence of increased variation as we pass from uncivilised and primitive people may of course be due to increased racial admixture as man grows older, or it may, as we believe, be due to less stringent dependence for survival on the physical characters in civilised man. But whatever its sources it seems fairly manifest in investigations of this kind, and must always be borne in mind when we are comparing races at different stages of development and at different historical periods.

For the remaining ratios we have not much comparative data. We note the following standard deviations:

Race.	Upper Face Index.		Orbital Index.		Nasal Index.	
	♂	♀	♂	♀	♂	♀
Bavarian‖	3·26	3·33	6·66	5·22	4·43	4·61
Naqada	4·52	4·15	*L.* 5·06 *R.* 5·00	4·57 4·78	4·18	4·86

There is not the same marked increased variability in the modern race here. But we see that for both races the woman is less variable in orbital index¶ and slightly more variable in nasal index than the man.

* Dr Alice Lee: *Phil. Trans.* Vol. 196, A, pp. 230 and 232.

† Unpublished values for the Whitechapel skulls deduced by Prof. Pearson.

‡ Deduced from Broca's MSS. measurements of the catacomb skulls by C. D. Fawcett.

§ Pearson: *The Chances of Death*, Vol. I. pp. 350—371, where more data as to the cephalic index will be found.

‖ Pearson: *The Chances of Death*, Vol. I. pp. 325—328.

¶ Confirmed by Pearson's reduction of Waischenfeld skulls, see *loc. cit.* p. 327.

Generally it will be realised that the cranial characters are not highly variable like the parts of plants, and that there is considerable agreement between results from very different races.

Turning now to the graphical and analytical representation of cranial variability, it was impossible to give diagrams of the 47 characters dealt with for the two sexes. Accordingly a choice was made of 12 characters, and the curves calculated and plotted in the 24 cases corresponding to these characters for the two sexes. The laborious calculations required are largely due to Dr Alice Lee, and for the draughtsmanship involved in converting her numbers into diagrams we have to thank Mr Karl Tressler, formerly one of the demonstrators in the Department of Applied Mathematics at University College, London. The general fit and smoothness of Mr Tressler's diagrams is the best verification of the accuracy and completeness of Dr Lee's work.

Now these diagrams are given with a view to bringing out a number of points. First and foremost to emphasise that no stress ought to be laid on the "peaks" of such frequency distributions as occur in most craniological investigations. These "peaks" are chiefly due to the fact that we are dealing with *very small* random samples. Few craniologists can work with more than 30 to 100 measurements of any character in one sex. In the next place sex-determination is only a *probable* determination; further, diversity of age, occasional foreign skulls, postmortem deformation and other causes produce heterogeneity. Lastly where a cemetery or local burial place has been plundered, we are certain to get family groups of skulls. All these causes tend to emphasise the irregularity of the distribution even beyond the limits of random sampling. We can only ask, are these small samples more variable—variability being measured by the standard deviation—than the largest and most homogeneous series known to us, such a sample for example as the "Altbayerisch"? If they are not, and the Naqadas are certainly not, then it is very unwise—nay, quite unjustifiable—to argue from a series of peaks as to racial mixtures. Even if like peaks occur in the two sexes for several characters the sources of heterogeneity given above are often ample explanation.

What we do see from these diagrams is that the curves which have already proved themselves sufficient for many frequency distributions in other living forms will suffice to graduate and smooth the frequency polygons obtained for short series of craniological measurements. They will serve for comparative purposes as soon as further series of craniological measurements have been reduced in the statistical manner advocated in this memoir. When once the craniologist has learnt to look upon his many peaked sample as the disturbed form of such smooth distributions, he will hesitate to make statistically unwarranted racial differentiations on the basis of such peaks. The question will then become: Is any system of peaks, allowing not only for random sampling, but for the above-mentioned sources of heterogeneity, really significant? In the state of our present ignorance, it is safer to be sceptical as to significance, than to build up on a statistically unsound foundation elaborate theories of racial mixture and racial relationship.

The curves we give in our diagrams are precisely similar to—showing neither greater nor less range than—those to which human, including cranial characters, closely approach in distribution, when we actually have the measurements on a large homogeneous population*. Hence we may fairly take them as representing cranial variation until more material is made available for comparison, especially in races of unquestionable purity.

Adopting the notation of the memoir on skew variation† we have the following system of constants for the 12 characters given in the first column, the second

TABLE XII.

Analytical Constants of Curves.

Character	No.	Unit	μ_2	μ_3	μ_4	β_1	β_2	Criterion	Mean	Mode	Skewness‡
L ♂	141	1 mm.	34·2740	13·5652	3120·00	·0046	2·6560	·7017	184·91	185·17	−·0450
L ♀	187	1 mm.	30·5756	19·9421	2903·14	·0139	3·1054	− ·1691	177·38	177·07	·0559
B ♂	139	1 mm.	21·5419	28·6959	1561·16	·0824	3·3642	− ·4813	134·77	134·19	·1247
B ♀	181	1 mm.	20·8101	1·3987	1125·26	·0002	2·5984	·8038	131·56	131·51	·0103
H ♂	134	1 mm.	28·9647	32·8925	2287·03	·0445	2·7260	·6815	135·21	134·47	·1385
H ♀	169	1 mm.	22·5375	21·5598	1464·20	·0406	2·8826	·3565	129·46	128·91	·1147
OH ♂	139	1 mm.	20·7052	9·0319	1449·16	·0092	3·3803	− ·7331	115·57	115·39	·0398
OH ♀	175	1 mm.	15·7281	− 23·7639	927·09	·1451	3·7477	−1·0600	112·57	113·14	−·1450
U ♂	116	3 mm.	20·0378	21·3658	1120·35	·0567	2·7903	·5896	510·98	508·97	·0356
U ♀	148	3 mm.	15·7876	18·0031	790·96	·0824	3·1734	− ·0997	493·92	492·20	·1390
S ♂	120	3 mm.	15·4287	6·3013	761·12	·0108	3·1074	− ·3623	373·06	372·51	·0425
S ♀	153	3 mm.	16·7380	8·2974	844·62	·0147	3·0156	·0129	364·31	363·57	·0606
Q ♂	115	2 mm.	25·8917	50·4615	1998·67	·1467	2·9814	·4773	304·29	301·97	·2279
Q ♀	150	2 mm.	18·9225	·2075	1129·17	·0000	3·1536	− ·3071	296·49	296·48	·0011
G'H ♂	84	1 mm.	17·1063	−17·9839	788·55	·0646	2·6948	·8043	67·61	68·35	−·0450
G'H ♀	117	1 mm.	18·5722	− 5·4600	942·44	·0047	2·7323	·5494	65·05	65·23	−·0422
NB ♂	84	1 mm.	3·7738	1·4915	38·7783	·0414	2·7229	·6783	25·17	24·91	·1333
NB ♀	116	1 mm.	3·0685	1·0370	28·1413	·0372	2·9888	·1341	24·28	24·10	·1010
NH ♂	88	1 mm.	8·9208	− 2·6028	250·32	·0095	3·1455	− ·2623	49·04	49·17	−·0450
NH ♀	121	1 mm.	10·2777	− 1·5166	265·10	·0021	2·5097	·9870	46·69	46·81	−·0359
B/L ♂	137	1 point	7·7552	2·9348	151·05	·0185	2·5114	1·0326	72·97	72·67	·1087
B/L ♀	181	1 point	9·4455	4·6788	261·60	·0260	2·9322	·2136	74·23	73·96	·0868
H/L ♂	131	1 point	7·2499	4·2003	166·40	·0463	3·1658	− ·1926	73·47	73·20	·1013
H/L ♀	159	1 point	8·6228	5·5811	219·76	·0486	2·9556	·2345	73·31	72·96	·1196

column gives the number of skulls upon which the calculations were based; these neither in total number, nor, if in total number, as individuals, are identical with those used for the results in Tables V^a and V^b. Thus the means and variabilities differ slightly, but always within the limits of probable error of random sampling.

* See for example: Bavarian Skulls, Cephalic Index. *Phil. Trans.* Vol. 186, A, p. 388 and diagram; *Biometrika*, Vol. I. p. 158. Breadth and Height of Head in Criminals, *Biometrika*, Vol. I. pp. 183—5 with diagrams.

† *Phil. Trans.* Vol. 186, A, pp. 343—414.

‡ Skewness = distance from mean to mode divided by the standard deviation.

These results were in fact first obtained from the measurements, but at a later date further skulls were found available for measurement. The third column gives the unit in terms of which the corresponding moment constants in the next three columns are expressed. Then follow the values of the numerical constants β_1, β_2 and the criterion $6 + 3\beta_1 - 2\beta_2$. Finally the mean and mode in the usual units and the skewness of the distribution. The actual equations to the 24 curves deduced from these constants with the origin in the same unit as the mean are given on the diagrams below. In these curves the unit of y is one individual per unit of x, and the unit of x is the unit given in the third column of Table XII. As a matter of practical use, it is sufficient in these cases to treat y as given by a scale of absolute frequency, which is indicated on the vertical to the left of the diagram.

Several points may be drawn from these analytical results.

(a) The skewness is negative in five cases only, or, looking at the diagrams, the mode is greater or falls to the right of the mean in only 5 out of 24 cases. But supposing the skewness to be merely a result of random sampling and not due to any bias in the organs in question, the probable error of skewness would be $\cdot 67449\sqrt{3/2n}$ where n = number of individuals dealt with*. We therefore conclude that for $n = 81$ to 144 observations, the probable error of skewness would be between ·09 and ·07. Thus in four out of the five cases, the skewness is only about half its probable error; in the fifth, the auricular height of the female, the skewness $= -\cdot 1450 \pm \cdot 0624$, and this may possibly be considered as significant. Of the positive skewnesses 8 are insignificant, and 11 certainly or probably significant. We may therefore conclude that:

In measurements on the skull, if the mode and mean do not coincide, the mean will almost invariably be greater than the mode.

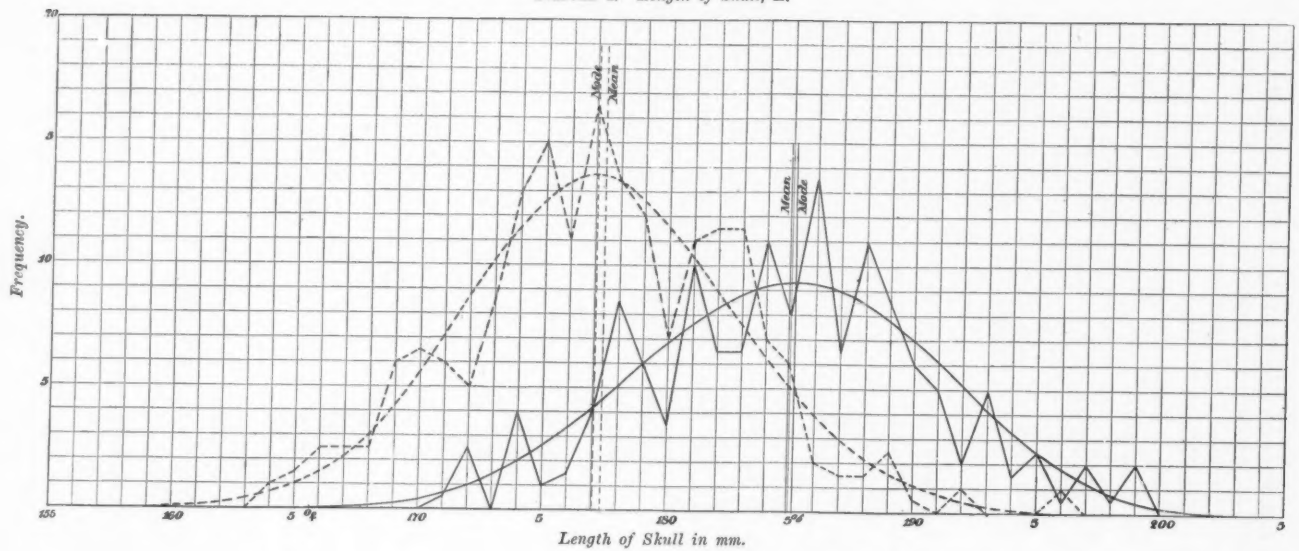
(b) Next let us examine the probable errors of $\sqrt{\beta_1}$, β_2 and the criterion†.

The probable error of $\sqrt{\beta_1}$ runs in our case from ·14 to ·18 roughly, according to the number in the series, that of β_2 from about ·28 to ·37 and that of the criterion from about ·56 to ·74. We notice at once that β_2 differs from 3 in only very few cases by an amount which is significant having regard to its probable error; the same is again true of the criterion, which differs from zero by quantities of the order of the probable error. $\sqrt{\beta_1}$ has deviations from zero, which are upwards of double its probable error in two or three cases, but on the whole we may conclude that:

With series of skull measurements such as the present, which are long for the craniologist, if short for the statistician, we shall reach for most practical purposes adequate graphical representations of the frequency by using the normal curve of deviations: $y = y_0 e^{-x^2/(2\sigma^2)}$.

* Pearson: "On the Mathematical Theory of Errors of Judgment," *Phil. Trans.* Vol. 198, A, p. 278.
† *Loc. cit.* p. 278.

DIAGRAM I. *Length of Skull, L.*



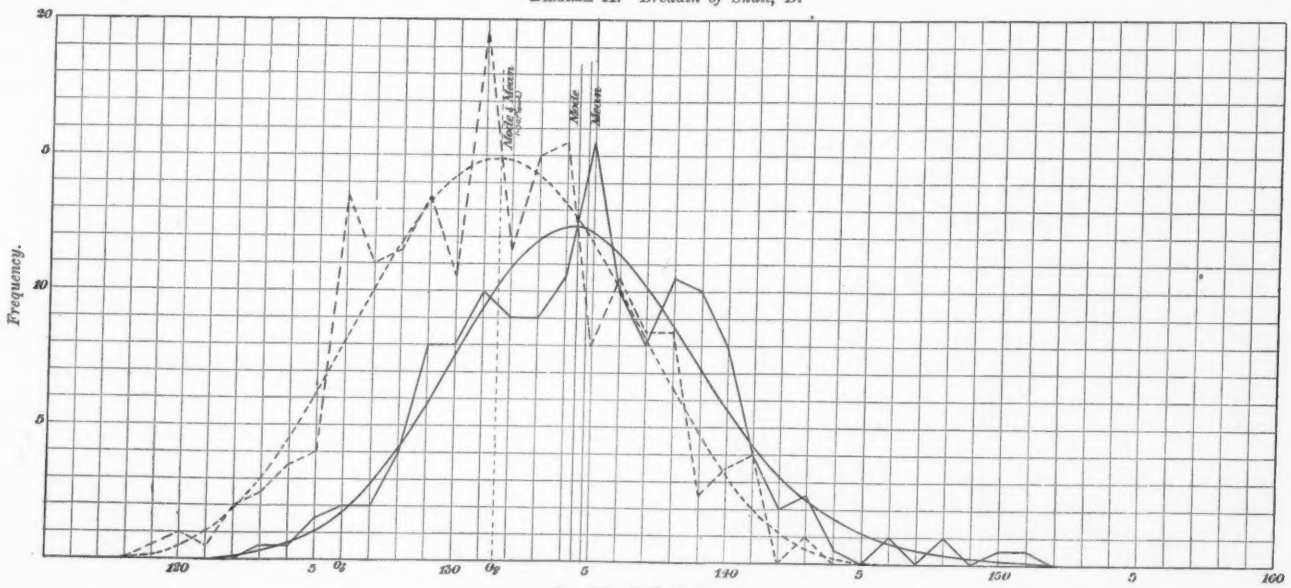
δ —— $y = 9{\cdot}311\left(1+\frac{x}{24{\cdot}679}\right)^{6{\cdot}554}\left(1-\frac{x}{20{\cdot}962}\right)^{5{\cdot}567}$.

Origin, 185·17.

♀ - - - - $y = 1{\cdot}288\cos^{76{\cdot}196}\theta\, e^{19{\cdot}063\theta}$, $x = 45{\cdot}820\tan\theta$.

Origin, 165·61.

DIAGRAM II. *Breadth of Skull, B.*



♂ —— $y = 1{\cdot}732 \cos^{30{\cdot}449}\theta \, e^{11{\cdot}056\theta}$, $x = 22{\cdot}665 \tan\theta$.

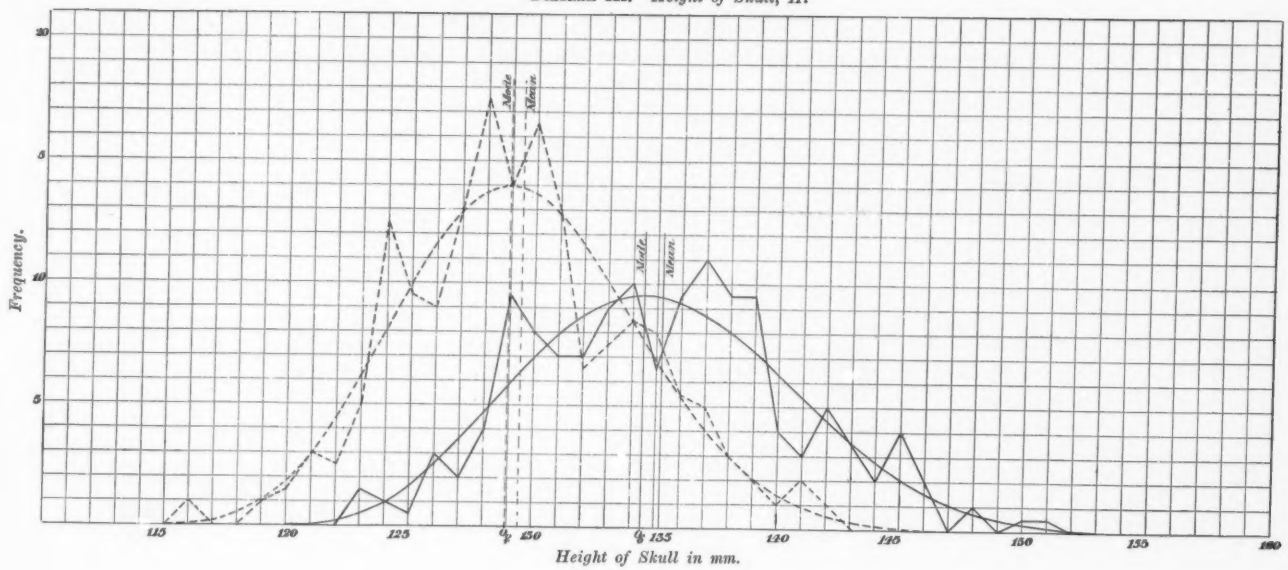
Origin, 125·96.

N.B. The draughtsman has in this curve inadvertently plotted the mode at 134·4 instead of 134·19.

♀ - - - - $y = 14{\cdot}89 \left(1 + \frac{x}{16{\cdot}124}\right)^{4{\cdot}880} \left(1 - \frac{x}{16{\cdot}686}\right)^{5{\cdot}050}$.

Origin, 131·51.

DIAGRAM III. *Height of Skull, H.*



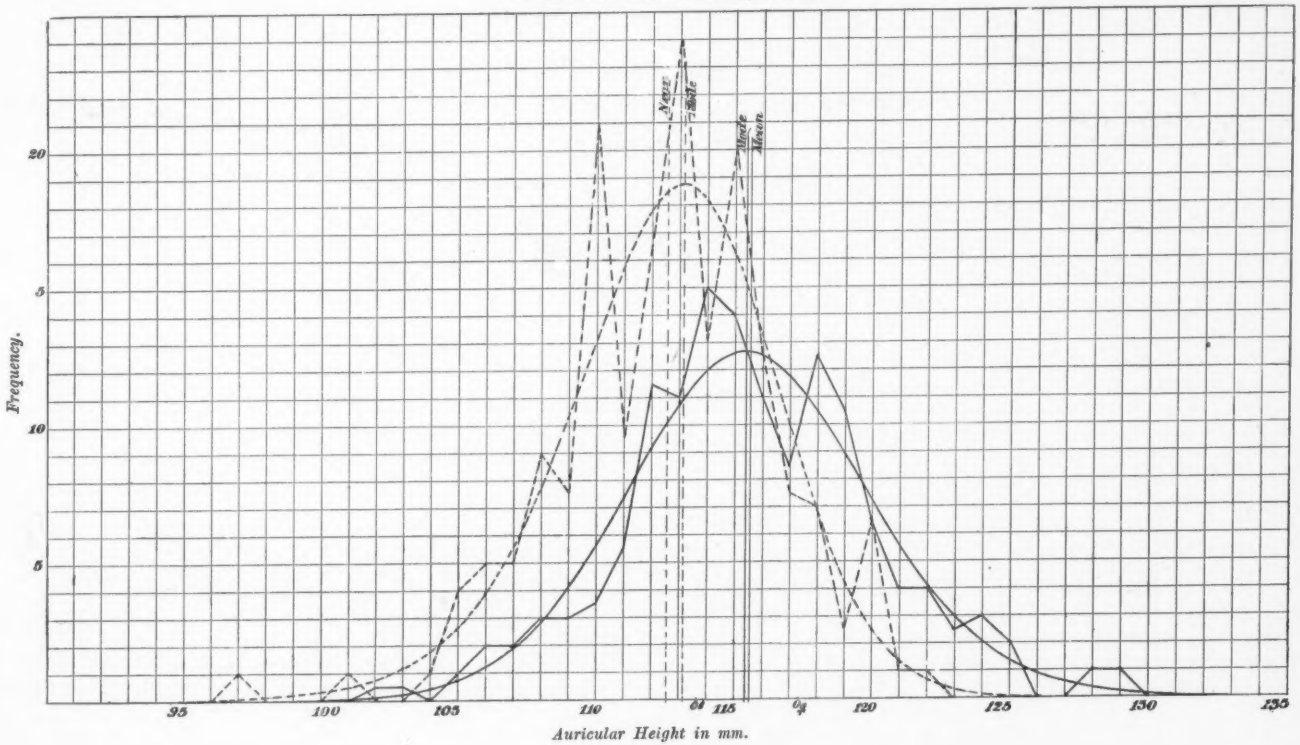
$$\delta \text{ ——} \quad y = 9{\cdot}517\left(1+\frac{x}{16{\cdot}405}\right)^{4{\cdot}791}\left(1-\frac{x}{27{\cdot}437}\right)^{8{\cdot}013}.$$

Origin, 134·47.

$$♀ \text{ - - - -} \quad y = 13{\cdot}936\left(1+\frac{x}{19{\cdot}554}\right)^{10{\cdot}129}\left(1-\frac{x}{36{\cdot}426}\right)^{18{\cdot}870}.$$

Origin, 128·91.

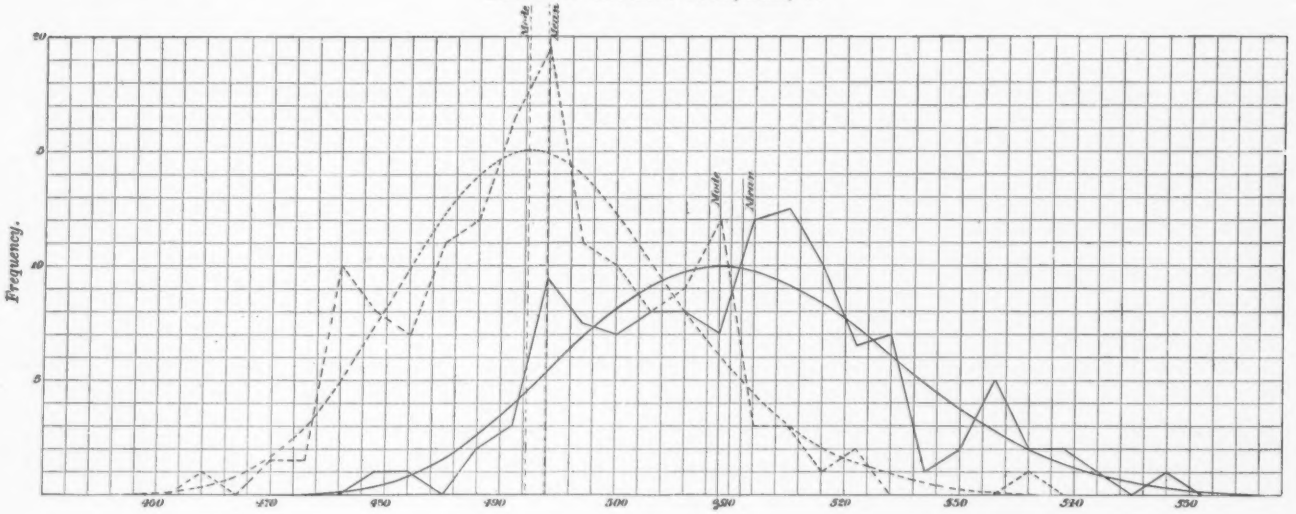
DIAGRAM IV. *Auricular Height, OH.*



♂ ——— $y = 11{\cdot}66 \cos^{24{\cdot}407}\theta\, e^{1{\cdot}896\theta}$, $x = 19{\cdot}430 \tan\theta$.
Origin, 113·67.

♀ - - - - $y = 8{\cdot}71 \cos^{16{\cdot}731}\theta\, e^{-5{\cdot}101\theta}$, $x = 15{\cdot}887 \tan\theta$.
Origin, 117·38.

DIAGRAM V. *Horizontal Circumference, U.*



Horizontal Circumference in mm.

δ —— $y = 9{\cdot}997\left(1+\frac{x}{14{\cdot}119}\right)^{5{\cdot}514}\left(1-\frac{x}{25{\cdot}929}\right)^{10{\cdot}127}$.

Origin, 508·97.

♀ - - - - $y = \text{Antilog}\,(\overline{37}{\cdot}033{,}1864)\cos^{127{\cdot}8556}\theta\, e^{165{\cdot}1064\theta}$, $x = 26{\cdot}915\tan\theta$.

Origin, 387·99.

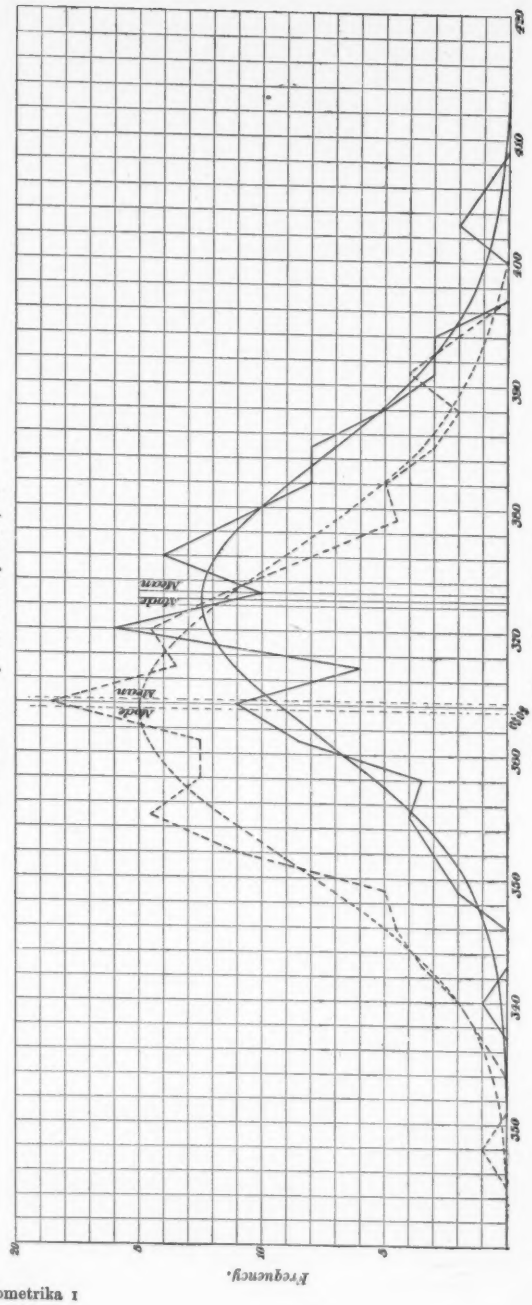
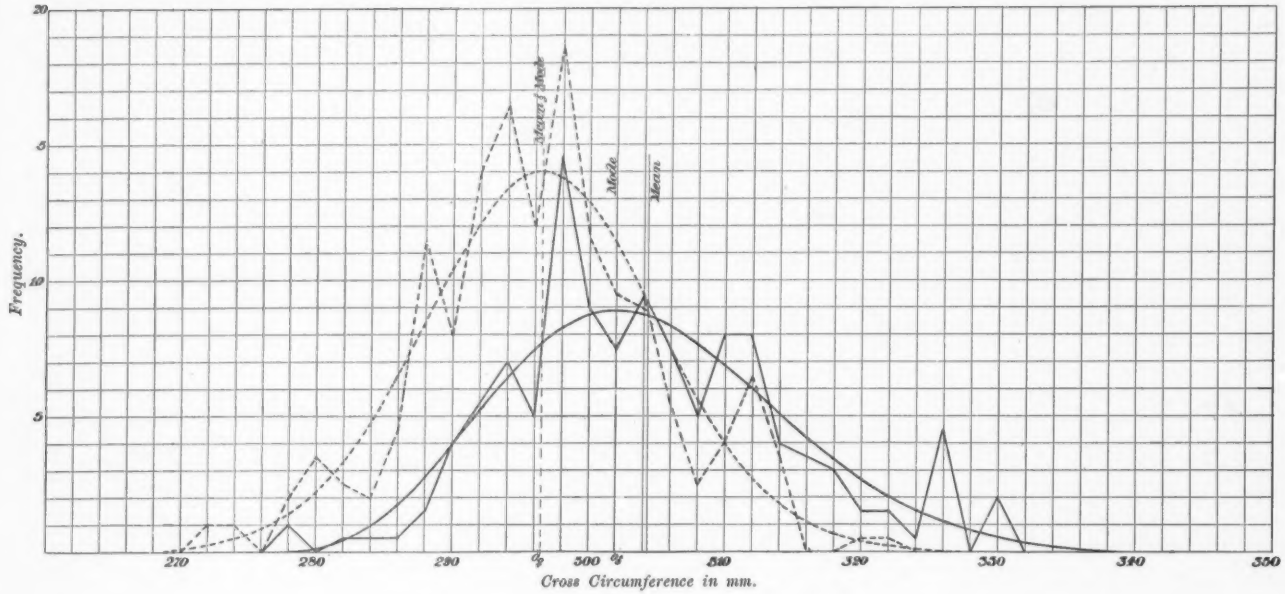


Diagram VI. *Sagittal Circumference, S.*

♂ ——— $y = 8{\cdot}4102\ \cos^{38{\cdot}211}\theta\ e^{5{\cdot}489\theta}$, $x = 23{\cdot}045\ \tan\theta$.
Origin, 362·58.

♀ · · · · · $y = 26{\cdot}30\left(1+\frac{x}{67{\cdot}264}\right)^{271{\cdot}341} e^{-4{\cdot}034x}$.
Origin, 363·57.

DIAGRAM VII. *Cross Circumference, Q.*



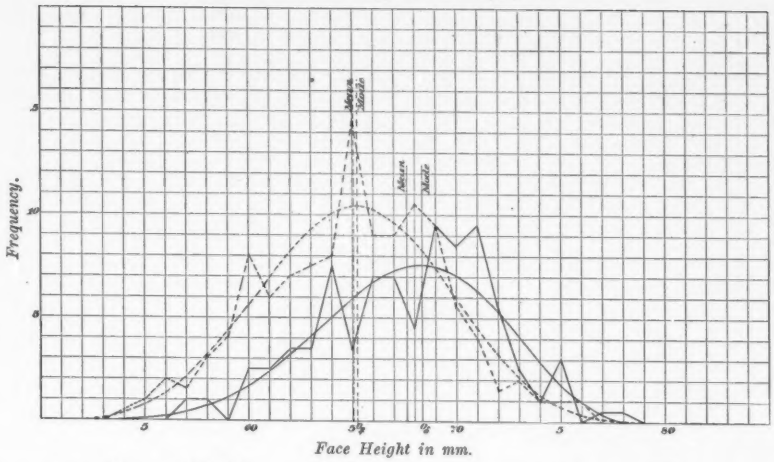
δ —— $y = 8{\cdot}90\left(1+\frac{x}{14{\cdot}416}\right)^{5{\cdot}464}\left(1-\frac{x}{55{\cdot}573}\right)^{15{\cdot}598}$.

Origin, 301·97.

♀ - - - - $y = 14{\cdot}00\cos^{44{\cdot}075}\theta\, e^{\cdot 166\theta}$, $x = 27{\cdot}879\tan\theta$.

Origin, 296·27.

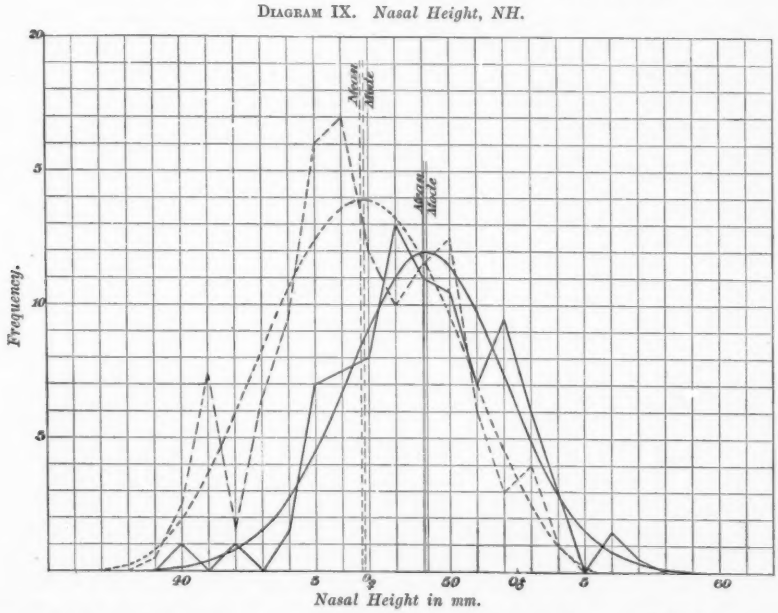
DIAGRAM VIII. *Upper Face Height, G'H.*



♂ —— $y = 7{\cdot}57\left(1+\frac{x}{19{\cdot}913}\right)^{6{\cdot}544}\left(1-\frac{x}{11{\cdot}005}\right)^{3{\cdot}616}$. Origin, 68·35.

♀ - - - - $y = 10{\cdot}42\left(1+\frac{x}{20{\cdot}987}\right)^{9{\cdot}186}\left(1-\frac{x}{17{\cdot}555}\right)^{7{\cdot}684}$. Origin, 65·23.

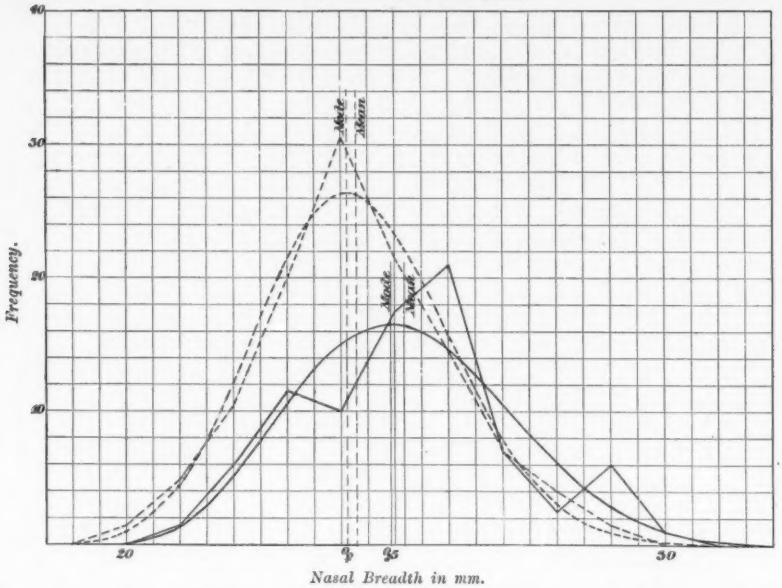
DIAGRAM IX. *Nasal Height, NH.*



♂ —— $y = 6{\cdot}19\cos^{50{\cdot}860}\theta\, e^{-8{\cdot}195\theta}$, $x = 20{\cdot}378\tan\theta$. Origin, 52·46.

♀ - - - - $y = 13{\cdot}92\left(1+\frac{x}{10{\cdot}756}\right)^{3{\cdot}767}\left(1-\frac{x}{9{\cdot}703}\right)^{3{\cdot}398}$. Origin, 46·81.

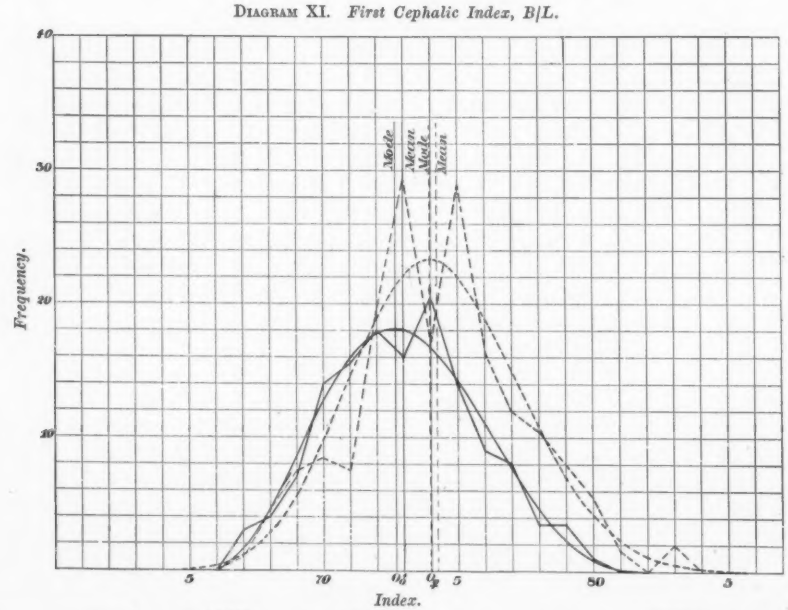
DIAGRAM X. *Nasal Breadth, NB.*



♂ —— $y = 16{\cdot}52\left(1+\frac{x}{5{\cdot}994}\right)^{4{\cdot}871}\left(1-\frac{x}{9{\cdot}844}\right)^{8{\cdot}003}$. Origin, 24·91.

♀ - - - - $y = 26{\cdot}30\left(1+\frac{x}{10{\cdot}381}\right)^{24{\cdot}463}\left(1-\frac{x}{25{\cdot}836}\right)^{60{\cdot}843}$. Origin, 24·10.

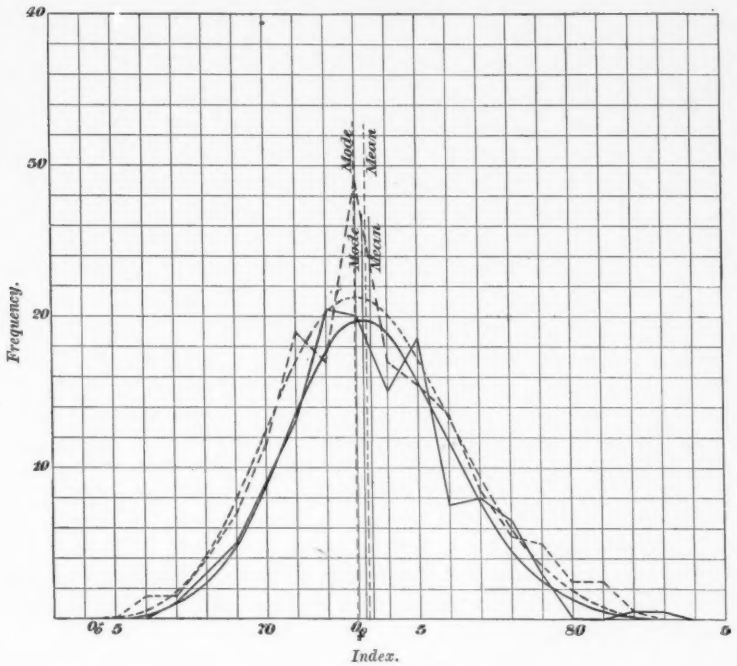
DIAGRAM XI. *First Cephalic Index, B/L.*



♂ —— $y = 18{\cdot}12\left(1+\frac{x}{7{\cdot}408}\right)^{2{\cdot}835}\left(1-\frac{x}{10{\cdot}033}\right)^{3{\cdot}840}$. Origin, 72·67.

♀ - - - - $y = 23{\cdot}24\left(1+\frac{x}{16{\cdot}576}\right)^{18{\cdot}016}\left(1-\frac{x}{30{\cdot}874}\right)^{33{\cdot}555}$. Origin, 73·96.

DIAGRAM XII. *Second Cephalic Index, H/L.*



♂ —— $y = \cdot 01954 \cos^{68\cdot023}\theta\, e^{31\cdot185\theta}$, $x = 19\cdot632 \tan\theta$.
Origin, 64·20.

♀ - - - - $y = 21\cdot39\left(1+\frac{x}{13\cdot721}\right)^{14\cdot401}\left(1-\frac{x}{30\cdot861}\right)^{32\cdot390}$.
Origin, 72·96.

Professor Weldon having urged the importance of comparing the actual goodness of fit of the skew and normal curves in at least one instance, we selected the breadth of the skull as an illustration, because this is a measurement, which, owing to the peaks of its curves, has already been used as an argument for racial mixture in the Naqada material. The female data (broken line, Diagram II., p. 445) provide a "mountain range" which many non-statistically trained craniologists would at once interpret as signifying racial mixture. Let us examine these data from the mathematical standpoint. The equation to the normal curve is: $y = 15\cdot829\, e^{-\frac{1}{2}(x/4\cdot5618)^2}$, the origin being at 131·56 mm. and the standard deviation being 4·5618 mm. The skew curve is given at the foot of the diagram, p. 445. The following are the observed and calculated frequencies:

mm.	Observed	Calculated Skew	Calculated Normal	mm.	Observed	Calculated Skew	Calculated Normal
119 & under	0·5	0·2	0·7	132	11·5	14·8	15·8
120	1·0	0·5	0·6	133	15·0	14·3	15·0
121	0·5	1·0	1·1	134	15·5	13·3	13·8
122	2·0	1·9	1·7	135	8·0	11·8	11·9
123	2·5	3·1	2·7	136	10·5	10·1	9·9
124	3·5	4·6	4·0	137	8·5	8·3	7·8
125	3·0	6·3	5·6	138	8·5	6·4	5·9
126	13·5	8·2	7·5	139	2·5	4·7	4·2
127	11·0	10·1	9·6	140	3·5	3·2	2·9
128	11·5	11·8	11·7	141	4·0	2·0	1·9
129	13·5	13·2	13·5	142	0·0	1·1	1·2
130	10·5	14·3	14·9	143 & over	1·0	1·0	1·1
131	19·5	14·8	15·7	Totals	181	181	180·7

Applying the test for goodness of fit*, we find for skew curve: $\chi^2 = 15{\cdot}65$ and $P = {\cdot}90$, and for normal curve: $\chi^2 = 17{\cdot}46$ and $P = {\cdot}83$. In other words, if the skulls, of which the Naqadas are a sample, obeyed the former frequency distribution we should get a more peaked polygon in 90 out of every 100 trial samples of 181 crania; and if they obeyed the latter, or normal distribution, in 83 out of every 100 trials. We see therefore quite clearly in a special case: first, that the multimodal appearance of short series of crania such as those represented in our diagrams may be wholly due to random sampling and be no sign of racial heterogeneity; secondly, that for many cranial series the normal curve, if it presents a worse fit than the skew curve, still gives a distribution quite good enough for most craniometric purposes.

This is not to be interpreted as meaning that skewness and the distinction of mode and mean are not to be regarded, when enough material is available. They may ultimately lead the craniologist to important conclusions such as that suggested above on p. 443, but the data provided by most craniological series is not sufficient to determine them with significance. In other words, our present more elaborate investigations justify for short series of craniological characters the use of the normal curve. It has already been shown that such use is justified as a first approximation in the case of many other characters in man†.

(10) *On the Correlation of Cranial Characters.*

Attention has already been drawn to the fact that the correlation of cranial characters in man is remarkably low and is also very irregular from race to race‡. Unfortunately cranial series are always relatively small, and a small series combined with low correlation means a high probable error. Further, if we add possible

* See *Biometrika*, Vol. I. p. 155.

† It is widely recognised now that the normal curve is not a general description of frequency. Hence its use for each class of cases must be independently demonstrated. Its simplicity and easy theoretical handling make any justification of its use such as the above of great importance.

‡ Pearson: *Phil. Trans.* Vol. 187, A, 1896, pp. 279—281; Boas: *American Anthropologist*, Vol. I. 1899, pp. 448 *et seq.*; Lee: *Phil. Trans.* Vol. 196, A, pp. 228, 229.

heterogeneity, errors of sexing, and clustering due to family entombments to these factors, we find that cranial characters do not provide the same sound basis for investigation that is provided by a small series of long bones. Nevertheless this fact in itself—irregular and low correlation of cranial characters—is of great importance and well worth ample demonstration. If craniologists as a body would once realise it, many wide generalities which now pass muster as craniological laws would be tacitly dropped. We may more or less safely argue from one race to a second in a long bone result, but it is almost impossible from a minute study of the individual crania of one race to argue as to what will hold for the crania of a second race. These low correlations of cranial characters and their divergent values from race to race seem to indicate that if the skull has been the subject of extremely stringent and varied selection, then this selection has not tended in the direction of relative proportioning of parts.

In calculating the correlation of cranial characters a selection had to be made among the 47 characters, the means and variabilities of which had been dealt with—otherwise we should have had 1081 possible pairs of characters to consider, and the arithmetic involved would have been interminable. Accordingly some 37 pairs of characters were taken as being those of special interest, and their correlation coefficients calculated for both sexes. In all these cases since the series are small it was considered best not to group the measurements into correlation tables but to proceed to the coefficient by calculating the sum of the products of the actual pairs of measurements. This involved considerably more labour, but it makes the results somewhat more reliable. It also frees us from the danger of drawing hasty conclusions from the graphical presentation of correlation results exhibiting the wide eccentricity due to the random character of small samples (see p. 425 footnote).

TABLE XIII.

Correlation of Naqada Cranial Characters.

Pair of Characters	No.	♂	No.	♀	Pair of Characters	No.	♂	No.	♀
L & *H* ...	134	·489 ± ·044	163	·283 ± ·048	*H*/*L* & *NB*/*NH* ...	71	− ·050 ± ·080	107	− ·132 ± ·064
L & *B* ...	139	·344 ± ·050	183	·143 ± ·049	*H*/*L* & O_2/O_1 (*L*) ...	70	·175 ± ·078	100	− ·002 ± ·067
B & *H* ...	129	·273 ± ·055	163	·119 ± ·052	*H*/*L* & O_2/O_1 (*R*) ...	73	·170 ± ·077	102	− ·016 ± ·067
					H/*L* & G_2/G_1 ...	59	·148 ± ·086	87	− ·041 ± ·072
C & *H* ...	86	·642 ± ·043	114	·519 ± ·046					
C & *B* ...	89	·434 ± ·058	123	·532 ± ·044	*B*/*L* & *NB*/*NH* ...	75	− ·148 ± ·076	110	− ·050 ± ·064
C & *L* ...	89	·501 ± ·054	123	·599 ± ·039	*B*/*L* & O_2/O_1 (*L*) ...	72	·106 ± ·079	102	− ·085 ± ·066
C & *Q* ...	84	·656 ± ·042	118	·603 ± ·039	*B*/*L* & O_2/O_1 (*R*) ..	74	·165 ± ·076	104	− ·036 ± ·066
C & *U* ...	84	·681 ± ·040	115	·723 ± ·030	*B*/*L* & G_2/G_1 ...	60	·317 ± ·078	88	·109 ± ·071
U & *Q* ...	84	·512 ± ·054	115	·454 ± ·050					
					NB/*NH* & O_2/O_1 (*L*)	77	− ·276 ± ·071	111	− ·263 ± ·060
O_1 & O_2 (*L*)	81	·434 ± ·061	108	·477 ± ·050	*NB*/*NH* & O_2/O_1 (*R*)	76	− ·323 ± ·069	113	− ·279 ± ·059
O_1 & O_2 (*R*)	82	·405 ± ·062	112	·510 ± ·047	*NB*/*NH* & G_2/G_1 ...	67	− ·194 ± ·079	97	·026 ± ·068
NB & *NH*	84	·343 ± ·065	116	·125 ± ·061					
G_1 & G_2	73	·202 ± ·076	105	·501 ± ·049					
GH & *GB*	77	·385 ± ·065	101	·479 ± ·050	G_2/G_1 & O_2/O_1 (*L*)	62	·118 ± ·085	93	·108 ± ·069
					G_2/G_1 & O_2/O_1 (*R*)	65	·177 ± ·081	94	·216 ± ·066

TABLE XIV.

Correlation of Naqada Cranial Characters and Comparison with French Values.

Pair of Characters	Naqada Race						French Race*					
	♂			♀			♂			♀		
	No.	Gross	Spurious	No.	Gross	Spurious	No.	Gross	Spurious	No.	Gross	Spurious
B/L & H/L	130	·284 ± ·054	·604 ± ·037	166	·371 ± ·046	·438 ± ·043	860	·489 ± ·018	·464 ± ·019	340	·576 ± ·024	·477 ± ·028
B/H & L/H	131	·595 ± ·038	·603 ± ·037	163	·527 ± ·039	·552 ± ·037	,,	·419 ± ·020	·527 ± ·017	,,	·417 ± ·030	·541 ± ·026
H/B & L/B	131	·601 ± ·037	·509 ± ·043	163	·594 ± ·035	·508 ± ·040	,,	·586 ± ·016	·508 ± ·018	,,	·503 ± ·027	·482 ± ·028
B/L & H	130	−·176 ± ·056	—	169	−·101 ± ·053	—	,,	−·040 ± ·024	—	,,	·068 ± ·036	—
B/H & L	131	·001 ± ·058	—	163	−·115 ± ·053	—	,,	−·170 ± ·023	—	,,	−·143 ± ·036	—
H/L & B	131	−·214 ± ·056	—	166	−·003 ± ·054	—	,,	·126 ± ·023	—	,,	·211 ± ·035	—
B/L & L	130	−·551 ± ·041	−·770 ± ·023	169	−·560 ± ·037	−·624 ± ·033	,,	−·652 ± ·014	−·686 ± ·013	,,	−·720 ± ·018	−·705 ± ·018
H/L & L	131	−·333 ± ·052	−·623 ± ·036	166	−·514 ± ·039	−·651 ± ·031	,,	−·548 ± ·017	−·677 ± ·013	,,	−·622 ± ·022	−·677 ± ·020
B/L & B	130	·594 ± ·038	·798 ± ·021	169	·695 ± ·028	·740 ± ·024	,,	·699 ± ·012	·727 ± ·011	,,	·729 ± ·017	·714 ± ·018
H/L & H	131	·660 ± ·033	·782 ± ·023	166	·677 ± ·029	·759 ± ·023	,,	·639 ± ·014	·736 ± ·011	,,	694 ± ·019	·736 ± ·017

* Paris Catacomb Crania deduced from copies of Broca's MSS. measurements sent by the kindness of M. Manouvrier to Prof. Pearson.

We must now proceed to consider these tables in detail, and compare the results with those for other races as far as such are yet known.

Length, Breadth and Height Correlations.

We note great sexual differences in these results, the males being twice as highly correlated as the females, but length and height in this dolichocephalic race are the most closely associated pair. We have here a good deal of material for comparison. We collect all available data in the following table:

TABLE XV.

Race	*L* and *H*				*L* and *B*				*B* and *H*			
	♂		♀		♂		♀		♂		♀	
	No.		No.		No.		No.		No.		No.	
French[a]	860	·294 ± ·022	340	·132 ± ·036	860	·089 ± ·024	340	− ·042 ± ·037	860	·224 ± ·023	340	·229 ± ·035
German[b]	100	[− ·096 ± ·067]*	99	[·314 ± ·061]*	100	·286 ± ·062	99	·488 ± ·052	100	[·072 ± ·067]*	99	[·276 ± ·063]*
English (Criminals)[c] ...	—	—	—	—	3000	[·402 ± ·010]†	—	—	—	—	—	—
English (Middle Classes)[c]	—	—	—	—	1000	[·345 ± ·019]†	—	—	—	—	—	—
Aino[b]	87	[·501 ± ·054]*	63	[·349 ± ·075]*	87	·432 ± ·059	63	·376 ± ·073	87	[·345 ± ·064]*	63	[·178 ± ·082]
Naqada	134	·489 ± ·044	163	·283 ± ·048	139	·344 ± ·050	183	·143 ± ·049	129	·273 ± ·055	163	·119 ± ·052
Sioux Indians[d]	57	· 36 ± · 08	—	—	57	· 24 ± · 08	—	—	57	· 00 ± · 09	—	—
Living Sioux[d]	—	—	—	—	243	[· 24 ± · 04]†	—	—	—	—	—	—
Eskimo[d]	—	—	—	—	47	· 47 ± · 08	—	—	—	—	—	—
Indians, B. Columbia[d] ...	—	—	—	—	?	[· 08]†	—	—	—	—	—	—
Shuswap Indians[d] ...	—	—	—	—	?	[· 04]†	—	—	—	—	—	—
Badenser[d]	—	—	—	—	?	· 09	—	—	—	—	—	—
Bágdi Caste, Bengal[d] ...	—	—	—	—	?	[· 13]†	—	—	—	—	—	—

* Auricular and not total height used and so not properly comparable.

† Measurements on living head and not skull.

(a) See footnote p. 456. (b) See A. Lee: *Phil. Trans.* Vol. 196, A, p. 231.

(c) Macdonell: *Biometrika*, Vol. I. pp. 181 and 188.

(d) Boas: *American Anthropologist*, Vol. I. p. 453.

It is impossible to disguise one's disappointment at the great range of results here exhibited. We see that the Aino are in fair agreement with the Naqada values, and both show uniformly greater correlation in the male. Both also are in fair accordance with the English measurements as far as the latter go. Even if we discard the last four series, no numbers being given, we are met at once by the remarkably low French results, where not only do both sexes show a low value, but they compare fairly well with results found for independent series of French skulls by Professor Pearson in 1896, i.e. Length and Breadth, Parisians, ·05 ± ·06 and French Peasants ·13 ± ·07*.

The German results also are very puzzling, even when we note that the total height has been replaced by the auricular height; for the same change has been made without apparent influence in the case of the Aino. The German sex differences are so remarkable and the divergencies from other races so anomalous, that one is driven to question the accuracy of measurement, of record or of arithmetic, until one sees the names of the measuring craniologist and the calculator! Clearly much more work remains to be done here, if possible on larger series, and where, if it can be provided for, craniologist and calculator are one. Meanwhile we must confess that the Naqada, Aino and English results strike us as the least improbable and inconsistent of the total material.

The craniologist who seriously examines these results must be convinced how little a study of one race can tell him of what is likely to occur in a second.

Capacity, and Height, Breadth and Length.

We have a certain amount of comparative data already available which is given in the table below:

TABLE XVI.

Race	*C* and *H*				*C* and *B*				*C* and *L*			
	♂		♀		♂		♀		♂		♀	
	No.		No.		No.		No.		No.		No.	
Naqada	86	·642 ± ·043	114	·519 ± ·046	89	·434 ± ·058	123	·532 ± ·044	89	·501 ± ·054	123	·599 ± ·039
German†	100	·243 ± ·064	99	·451 ± ·054	100	·672 ± ·037	99	·706 ± ·034	100	·515 ± ·050	99	·687 ± ·037
Aino†	76	·544 ± ·054	52	·521 ± ·068	76	·561 ± ·053	52	·502 ± ·070	76	·893 ± ·016	52	·663 ± ·053
Sioux‡	57	· 44 ± ·07	—	—	57	·67 ± ·05	—	—	57	· 54 ± ·06	—	—
Means	—	·47	—	·50	—	·58	—	·58	—	·61	—	·65

* *Phil. Trans.* Vol. 187, A, p. 280. † A. Lee: *Phil. Trans.* Vol. 196, A, p. 231.

‡ Boas: *The American Anthropologist*, Vol. 1. p. 458. Boas apparently correlates the lengths with the cube root of the capacity, but the coefficients ought from theoretical considerations to be sensibly the same as if he had correlated with the capacity itself.

The means have been taken without weighting the series. On the whole the results here are much more consistent than in the last table, the Germans being most anomalous in C and H ♂, and the Aino in C and L ♂. The means probably give very fair average results, which will serve for general racial comparison. They show on the whole no very marked sexual preponderance in correlation, although such undoubtedly exists in individual races, e.g. German female is sensibly more, Aino female is sensibly less, correlated than the male. There is small doubt that these capacity correlations come out better than those between the lengths chiefly because they are higher, and accordingly the probable errors of random sampling less. Possibly the best method of dealing for the present with the latter will be to investigate them for long series of measurements on the living, replacing the total height of the skull by the auricular height of the head.

Capacity and Circumferences.

We have at present very limited data for these cases, only indeed the Thebans and Naqadas:

TABLE XVII.

Race	C and U				C and Q				Q and U			
	♂		♀		♂		♀		♂		♀	
	No.		No.		No.		No.		No.		No.	
Naqada*	84	·681 ± ·040	115	·723 ± ·030	84	·656 ± ·042	118	·603 ± ·039	84	·512 ± ·054	115	·454 ± ·050
Theban Mummies†	202	·813 ± ·016	96	·826 ± ·022	202	·788 ± ·018	96	·673 ± ·038	202	·665 ± ·027	96	·625 ± ·042

Considering the close relationship of Naqadas and Thebans these results are singularly different, but we must remember that it is precisely in length and breadth that differentiation has been shown to have taken place, and these would directly affect the correlationship of circumferences.

The historic Egyptians show in every case higher correlation than the Naqadas, and in both series with one exception the males are more highly correlated than the females. The divergence between the sets of values for two so closely allied series indicates how difficult it would be to reconstruct satisfactorily skull-capacity from any general formula connecting capacity and the circumferences.

* These results are for a rather more extensive series of skulls than those dealt with by Dr A. Lee: *Phil. Trans.* Vol. 196, A, p. 261.

† *Phil. Trans.* Vol. 196, A, p. 262.

Facial and Palate Measurements.

The correlation of breadth and height of orbit is fairly constant, say ·45, for both eyes in both sexes, the female orbit has its parts, however, somewhat more highly correlated. The same sexual advantage occurs more markedly in the length and breadth of palate and significantly, if less markedly, in height and breadth of face. On the other hand the male breadth and height of nose are more closely correlated.

We have absolutely no data available at present for comparative purposes.

Index Correlations.

Here again the results of the present paper embrace nearly all we at present know*. But they lead to several suggestive hints for further investigation. We may note that:

(*a*) In both sexes chamaecephaly is associated with platyrrhiny.

(*b*) In the male chamaecephaly is also associated with chamaeconchic and brachystaphyline characters, but in the female there is no really sensible relationship between the shape of palate or orbit and the height-length cephalic index. What little relationship there is tends to mark an association between chamaecephaly and hypsiconchic and leptostaphyline characters.

(*c*) In both sexes brachycephaly is associated with the leptorrhine and brachystaphyline characters.

(*d*) In the male brachycephaly is associated with hypsiconchic, in the female with the chamaeconchic character; in the latter sex the association is much smaller.

(*e*) In both sexes there is a quite sensible association of platyrrhiny with chamaeconchy, or when the nose is flat the eye is oval.

(*f*) In the male platyrrhiny is associated with the leptostaphyline character, but in the female there is practically no relationship of the nose and palate characters.

(*g*) In both sexes there is sensible correlation between the palate and orbital indices, hypsiconchy being associated with brachystaphyline characters.

All these results, it must be borne in mind, are relations between the characters of individuals *within the race*, and indicate how, if an individual differ from the mean in one character, he or she will be likely to differ from it in a second. They must not be extended without further consideration from association of deviations within the race to association of racial characters. Still a consideration of Table XIV. shows that they may be suggestive also in this direction. The correlation

* Dr Lee's correlations of cephalic index and capacity for Germans, Ainos, Thebans, Copts, Malays, Etruscans and French are the only other cases we know of: see *Phil. Trans.* Vol. 196, A, p. 232.

of the *mean values* of the chief cranial characters in 50 to 100 races would be a most valuable investigation, breaking practically untrodden ground. We want an *interracial* as well as this *intraracial* correlation, to show us how far it is safe to generalise from what occurs within a race to what will happen when we compare races together. If platyrrhiny is associated with chamaeconchy for individual Naqadas, is it right to generalise and say that the platyrrhine races of men are also chamaeconchic? Probably, but there is no proof, until someone has actually worked out interracial coefficients of correlation.

Cephalic Indices and Length, Breadth and Height.

The correlations of the cephalic indices are of such importance that a special consideration of them as well as their relationships to length, breadth and height was desirable. For comparative purposes the Paris catacomb crania were worked out at the same time. The formulae used in the investigations were those given by Professor Pearson in his paper "On a form of Spurious Correlation which may arise when Indices are used in the Measurement of Organs*." In every case where it exists, the value of spurious correlation has been calculated: see Table XIV. p. 456. In order, however, to test the accuracy of the results reached by these formulae from the recorded values of the coefficients of variation (Table XI.) and the length, breadth and height correlations (Table XIII.), in two cases the correlations were worked out *ab initio*, namely from the data given in the Appendix of measurements to this memoir. There resulted:

Correlated Pair	From Formula	From Measurements
B/L and H/L ♂	·490 ± ·018	·500 ± ·018
B/L and H/L ♀	·576 ± ·024	·572 ± ·025

The results are in such good agreement, well within the limits of the probable errors, that it seems unnecessary to deduce in future any such correlations directly from the measurements.

Now turning to our results themselves, Table XIV., we see that where the spurious correlation exists it is at least of the same order and very frequently sensibly larger than the gross correlation. In fact the organic correlation between L, B and H often tends to reduce the result considerably below the value it would have if the lengths, breadths and heights had been selected from the records in random triplets, i.e. below the spurious correlation. Thus the correlation of the two chief cephalic indices for male Naqada is reduced from ·604 to ·284. In the case of the French males it is raised from ·464 to ·489, which is fairly in keeping with Professor Pearson's result for Bavarians ♂, i.e. ·401 to ·486†, the only other comparable values at present known.

* *R. S. Proc.* Vol. 60, p. 493. Formula (iv) and (vi).

† *R. S. Proc.* Vol. 60, p. 495.

It will be seen at once from these results that if an individual tends to brachycephaly he will also tend to hypsicephaly. Further, we ask, are the brachycephalic races hypsicephalic and the dolichocephalic races chamaecephalic? Again we want our interracial coefficients of correlation to answer this problem satisfactorily.

If we turn to the correlation between the indices and the lengths they do not involve, we find:

(*a*) For both sexes in Naqadas brachycephaly is associated with hypsicranial characters. Among the French there is practically no association at all.

(*b*) For both sexes of the Naqadas hypsicephaly is associated with platycranial characters. On the other hand, for both sexes in the French, hypsicephaly is united with stenocranial characters.

(*c*) In both races platycephaly is associated with brachycranial characters—the association vanishing, however, for the Naqada males, and being more marked for the French.

Lastly turning to the relations between the indices and the absolute lengths they involve, we conclude that

(*d*) Dolichocephaly and chamaecephaly in both races are associated with macrocranial characters.

(*e*) Brachycephaly is associated with platycranial characters in both races.

(*f*) Hypsicephaly is associated in both races with hypsicranial characters.

In (*d*), (*e*) and (*f*) the association is really produced entirely or almost entirely by the spurious correlation.

Here, again, a whole range of racial problems are suggested which can only be dealt with by interracial correlation investigations.

It should be noted that throughout the above statements we have used technical terms for brevity in an *intraracial* sense.

By dolichocephalic, chamaecephalic and stenocephalic crania *within the race* we understand those of individuals having their B/L, H/L and B/H indices below the racial mean; by brachycephalic, hypsicephalic, platycephalic crania, those of individuals having the corresponding indices above the mean. By brachycranial, stenocranial and chamaecranial characters we describe those of individuals with cranial length, breadth and height below the racial mean, and by macrocranial, platycranial and hypsicranial characters those of individuals with length, breadth and height above the racial mean. As soon as we can find interracial means—means of racial means—we shall be able to use these terms also in an interracial sense, which will be somewhat less arbitrary than that of the *Frankfurter Verständigung*; that concordat really fixes rough numbers to represent unknown interracial results.

Here we must conclude for the present our discussion of the correlation of cranial characters. We see that except where one of the characters is capacity,

all such correlations as have hitherto been calculated are remarkably small and remarkably divergent from race to race. Where they appear to be high, as in Table XIV., the result is solely due to what has been termed spurious correlation. Of course when many more characters have been dealt with, some high organic correlations may be discovered, but this discovery can hardly now upset the general principle that the bulk of cranial characters have far smaller correlation than the larger bones of the skeleton or than the bones of the hand. This principle must somehow be deducible from the general course of cephalic evolution in man, but until many more races have been statistically treated, if possible in far larger cranial series, and what we have termed interracial correlation coefficients have been determined, it would be idle to speculate on what this low correlation of cephalic characters really denotes from the standpoint of evolution*. One must be content at present to accumulate material for future interpretation. But enough has been indicated in this memoir to show the wide field which is open to craniologists, who will adopt the more recent mathematical methods in statistics. There is an immense amount of work to be done in tabling both intraracial and interracial means, variabilities and correlations. In many cases the measurements are already provided, but for certain characters it is very desirable that a revised and more definite concordat, international if possible, should supplement the *Frankfurter Verständigung*. The object of the present memoir has been to point out some defects of the older methods and to emphasize the importance of the new. The conviction of the mathematical contributors to this memoir is, that if they have done but little it is not the fault of the new methods, but of their individual want of skill, especially their want of previous anatomical training.

The measurements and calculations given in detail or in the form of coefficients in this memoir have been the labour of upwards of six years, and it may be proper to again refer here to the distribution of labour, and the many friends to whom acknowledgment of assistance and counsel is due. Two-thirds of the measurements and the first work on most of the calculations are due to the author; an independent verification of her calculations and a considerable number of additions are due to Dr Alice Lee, whose name is therefore added to the title. To Miss M. Lewenz are due the solutions of the triangles on which all the angle measurements depend, and the determination of the angular means and variabilities. To Mr N. Blanchard we owe the reductions of the Negro crania.

We have already referred to Mr Karl Tressler's work on the diagrams; to Mr Radford Sharpe's preparation of the photographs for the plates; to Mr Herbert Thompson's determination of some of the length, breadth and height measurements and a first series of capacities; and to Dr E. Warren's help in a variety of ways, especially in determination of sex and in the suggestions which flowed from his memoir on the Naqada skeletons. To Professor Thane we owe the most cordial thanks for his ever ready advice and assistance, and the same is true of Professor

* Compare, however, the relatively lower correlations of certain parts of the hand-skeleton, *Biometrika*, Vol. I. p. 359.

Weldon, who spent several days in going through the material with a view to noting anatomical peculiarities and selecting typical crania for reproduction. Lastly to Professor Flinders Petrie we owe not only the information acknowledged earlier, but the skulls themselves.

If the professed craniologist should feel aggrieved that such splendid material should have fallen at first into mathematical hands, he may console himself with the knowledge that the crania will be available for further work when they ultimately reach the Anatomical Museum at Cambridge. He must also remember that the material was dug up and brought to this country with this direct purpose in view—that it should be used for the illustration of statistical methods as applied to craniometry,—and that however little sympathy he may have with these methods, without them the present material would certainly not have been brought to England when and how it was. Let us hope that he will in the end pardon the method and even the errors of this paper for the sake of such material as it has indirectly made available for craniological purposes.

(11) *Summary of Conclusions.*

(*a*) Craniometry cannot in future content itself with either the raw measurements, tables of mere averages, or graphical exhibition of correlation results, but must adopt the methods of modern statistical investigation, tabulating means, variabilities, correlations, and their probable errors in order to draw safe inferences and make racial comparisons.

(*b*) The prehistoric Egyptians as represented by the Naqada crania appear to be as homogeneous as most short series which pass muster as racial unities.

(*c*) The Naqada race does not appear substantially nearer to the Negro—as judged by his modern representative—than the historic Egyptian as sampled in the Theban mummies or than the modern Copt.

(*d*) In some features only the Naqada crania are "primitive or inferior," in others they are "advanced or modern." In some characters they resemble the Negro, in others the European.

(*e*) The close resemblance in the majority of characters of Naqadas, Thebans and Copts leads one to believe that one is examining substantially the same race at intervals during 8000 years.

(*f*) The progressive divergence in certain characters of these three series of crania ought, we hold, to be attributed to an evolution tending in a fixed direction. If this be so we have an actual measure of the rate at which evolution can modify characters.

(*g*) The relationship between cranial characters as exhibited by their coefficients of correlation in the case of the Naqada and other races is seen to be low, and to vary much from race to race. It is therefore very doubtful how far it

is legitimate to press results found for individuals of one race upon those of another. We cannot pass from intraracial to interracial conclusions, but we must work towards a knowledge of interracial correlation, and the first step in this direction should be to obtain the average values of some 40 to 50 characters in 50 to 100 races measured on some uniform plan. Only on such interracial correlations will it be possible to establish a properly founded statistical theory of race in man.

DESCRIPTION OF PLATES.

PLATE IV.

Craniometric Apparatus: see pp. 413—14.

PLATE V. *Male Crania.*

Q. 392 (Top)	T. 10^{B} (Top)	T. 29^{A} (Top)
Q. 392 (Front)	T. 10^{B} (Front)	T. 29^{A} (R. profile)
Q. 392 (Back)	T. 10^{B} (Back)	T. 29^{A} (Back) *Torus occipitalis*

PLATE VI. *Male Crania* (continued).

Q. 758 (Top)	530 (Top)	1755 (Front and mandible) Persistent frontal suture
Q. 758 (R. profile)	530 (R. profile and mandible)	1755 (R. profile and mandible)
Q. 392 (Base)	T. 10^{B} (Base)	T. 10^{B} (R. profile)

PLATE VII. *Female Crania.*

1308 (R. profile and mandible)		Q. 326 Lower (L. profile)
1308 (Front)	Q. 326 Lower (Front)	R. 2 (Front)
Q. 326 Lower (Top)	R. 2 (Top)	

PLATE VIII. *Female Crania* (continued).

Q. 408^{D} (R. profile)	R. 2 (R. profile)	
Q. 326 Lower (Base)	Q. 408^{D} (Base)	R. 2 (Base)
Q. 408^{D} (Back)	R. 2 (Back)	

Juvenile, interparietal and wormian bones

PLATE IX. *Abnormal and Special Crania.*

1644 (R. profile) Curved dental arch	Q. 791 (R. profile) Depressed obelion	1300 (R. profile) Negroid, prognathous	1377 (R. profile) Fused atlas and axis
R. 5 (R. profile) Very strongly marked lower temporal line	Q. 383 (R. profile) Markedly convex and sloped occipitals	Q. 359^{2} (R. profile)	1446 (Base) Fused atlas

PLATE X. *Abnormal and Special Crania* (continued).

1587^{4} (Top) Much emphasised upper temporal lines	Q. 18 (Top) Scaphocephalic	1031 (Base) Markedly arched palate, characteristic worn molars	B. 83 (Domes) Much distorted infant skulls *
1587^{4} (Back) Much emphasised upper temporal lines	1587^{4} (R. profile)	Q. 513 (R. profile) Sloped occipital *Torus occipitalis*	T. 5^{F} (Top) Os anti-epilepticum, persistent frontal suture

* To indicate the immense possibilities of *postmortem* deformation, here of course on exaggeratedly plastic material.

(12) *Appendix of Tables of Cranial measurements.*

The Naqada Crania, as already stated, were brought to England in 1895, and deposited at University College, London. Unfortunately the cramped accommodation of that institution did not permit of any proper room being appropriated to them in term time. They occupied two small lecture rooms while Mr H. Thompson was measuring F, L, B, H and C. They were then transferred during vacation time to a gallery of the Anatomical Museum where Dr E. Warren was dealing with the skeletons. Thence they passed to the Biological Laboratory, where C. D. Fawcett started her work. Changes there involved their being removed to the South Library, where they were much in the way of other workers, and finally they were deposited in the Instrument Room of the Department of Applied Mathematics. It is necessary to emphasise these points, for they will explain why (i) it has never been convenient to have the whole series of skulls out for examination at the same time; (ii) it has only been possible with great labour to reach any individual skull required for re-examination, since the boxes had to be stacked in columns eight or ten high and in rows four or five deep. In many cases the skulls had been placed at some time or other by the packers in the wrong boxes, and quite a number of skulls or boxes had duplicate numbers. Lastly the whole material was (and remains of course) excessively fragile, and the repeated removals, however carefully conducted, were very far from desirable. In any case where a skull was known to be more perfect when first examined by Mr Thompson, than when the series was last gone through in January 1902, the *Remarks* contain the words "when broken?"

In the last examination of the whole series, Professor Pearson, with assistance in holding two or three fragments together, added several hundreds of measurements to C. D. Fawcett's series. Many of these are queried, but the remainder were obtained too late to be included in the determination of the statistical constants. Thus 28 additional values of the face-height of which only 55 values had been previously taken were found, and some of the other measurements were increased in the same proportion. They are now available, however, for any later comparison with other material.

At the same time Professor Weldon went through the whole series, dealing with probable age, sex in some unsettled cases and abnormalities. He further selected types for photographic reproduction. A select series was further considered later by Professor G. Thane, who kindly described some of their chief anatomical peculiarities.

But while most hearty thanks are due to Professors Thane and Weldon and also to Dr E. Warren for their aid, which has been most generously given whenever asked for, the statistical workers at University College must take upon their own shoulders all errors of description and blunders of measurements which occur in these tables. They have done their best to reduce them to a minimum, but the magnitude of the task undertaken, the time during which it has been in progress, and the novelty of the attempt—the endeavour to apply modern statistical methods for the first time to an original series of craniological data—must be some excuse for imperfections which undoubtedly will be found. The main object in view has been to indicate the mathematical theory which it will be necessary for the craniologist in the future to apply to similar data.

The following abbreviations have been used in the *Remarks*. cr. = *cranium*, i.e. skull + mandible. cal. = *calvarium* = skull − mandible. f. stands for face. Thus cal. − f. = skull − mandible − face bones, or what some Germans write *calvaria*, the "Hirnkapsel." dome = what some Germans write *calvaria'*, or the "Schadeldach" alone. Of course there are different stages of all these classes. Thus 'cal. − part f.' means that a portion of the face has disappeared.

Series No.	Grave No.	Sex	C	Lengths								Circumferences					
				F	L′	L	B	B′	H	OH	LB	U	S	Q	GH	G′H	GB
1	3	?	—	—	—	179?	—	—	—	104 (*h*)	—	—	—	—	—	—	—
2	7	♀	—	179	—	179	138	92	—	115 (*h*)	—	—	—	—	—	—	—
3	12	♂	—	184·5	—	183	135·5	—	132·5	—	—	—	—	—	—	—	—
4	13	♀	1151	165	—	166·2	129·5	—	133·5	—	—	—	—	—	—	—	—
5	15	♀	1184	166	166	166·5	129·6	87	124	110	86	476	357	289	—	60	95
6	16	♂	—	188	—	188·5	137·5	—	143·5	—	—	—	—	—	—	—	—
7	52	♂	1345	181	182	182	134·5	89·5	128	112·5	99	507·5?	360?	293·5?	—	68	103
8*a*	53	♂	1313	191	—	191·5	135	—	140·5	—	—	—	—	—	—	—	—
8*b*	85	?	—	—	—	178?	136?	94	—	—	—	—	—	—	—	—	—
9	108*a*	?	—	—	—	188?	136·5	103	—	106?	—	—	—	—	—	—	—
10	114	♀	1360?	177	177	177	139·5	95·5	131·3	115·75	96·5	497	363	310	115	69·25	97
11*a*	121	♀	1440	—	181·5	179	139·5	96·5	141	119	94·5	509	382	313	—	67	100·25
11*b*	160	?	—	—	—	190	—	—	—	—	—	—	—	—	—	—	—
12	193	♂	1264	182	181	181·5	128	92	134·5	114	93	498	376	303	—	—	—
13	245	♂	1433	185	188·5	188	139	100	129·5	114·8	100	521	370	313·5	117?	72·5	92
14	282	♀	—	—	—	—	—	89·5?	—	—	—	—	—	—	—	—	—
15	314	?	—	—	182?	—	—	85	—	116	89?	—	—	308?	—	58	79
16	315	♂	—	184	—	184	147·7	—	138	—	—	—	380?	335?	113?	71	—
17	318	♂	1495	188	186	188	138·5	95·5	134·5	117·5	98	520	385	312	—	—	—
18	328	♂?	—	—	—	174	128·5	76	123·5	112 (*h*)	—	—	—	—	—	—	—
19	342	♀	—	179·5	176	181	131·5	91·5	—	112	—	500	—	294	—	—	—
20	358	♂	—	—	166?	169	128	90·5	130?	111 (*h*)	95·5	—	340·5	—	102·5	60	89
21	366	♂	1373?	181·5	—	183·5	137·5	101	—	116?	—	512	364	305	—	—	—
22	368	♂?	—	—	185·5	—	138	—	139	117·5	—	—	—	—	—	—	—
23	384	?	—	—	177	—	—	87	—	123	93	488	387·5	314·5	—	59·75	85·5
24	386	♂	—	—	—	—	—	98·75	—	117·5 (*h*)	—	—	—	—	—	—	—
25	391	♀	—	176	177	176	138	93	120	114·75?	93·5	502	362	308	—	—	—
26	393	♂	1695	191	194	193	140	100·6	139	121·5	113	534	386	317·5	—	69	98
27	396	♂	—	—	—	197·5	150·5	92·5	147·75	112 (*h*)	—	547?	—	—	—	68·5	—
28	426	♂?	—	—	—	—	—	84	—	—	—	—	—	—	—	—	—
29	519*a*	♀	—	—	186	184	127?	88·5	131	113·75	99	—	382	298	—	67·5	90
30	522?	♂?	—	—	—	—	—	—	—	113·75	—	—	—	—	—	—	—
31	527	♀	—	176	177·5	177	128·5	84·5	129	106	96	485?	356	272?	—	68·8	93
32	530	♂	1320	177·5	178	178	136·5	89	123	111	92	499	351	298	106	64	89·5
33	531	♀	—	—	—	177	130	93·75	—	101 (*h*)	—	494	—	—	—	—	—
34*a*	534	♂	—	174·5	—	178	134·5	—	126	—	—	—	—	—	—	—	—
34*b*	536	?	—	—	—	191·5	—	—	—	—	—	—	384	—	—	—	—
35*a*	541	♀	—	191	188	189·5	139·5	93	134·5	120	96	521?	390	321?	—	—	—
35*b*	548	?	—	—	—	—	138?	85	—	—	—	—	—	—	—	—	—
36	554?	♂	—	—	—	177	133·5	95·75	134	112·5	101·5	495?	355	296?	—	—	—
37	592	♂	—	—	191	191	129	89·8	133	111·6?	—	518?	378·5	293?	—	—	—
38	598	♂?	—	—	189	190	139·5	95	136	119	96	533?	384?	321·5	—	69	104
39	618	♂?	—	179	—	180	126·5	89·5	131	—	—	—	—	—	—	61?	—
40	646	♂	—	—	192?	—	—	92	—	123	101	—	—	—	—	66·5	95·5
41	660	♂	—	179	182	181	128·5	89	127	113·5	—	498	361	292	—	—	—
42*a*	693	♂?	1340	179	178·5	178	134·3	100·5	129	112	95	505·5	354	300	109?	69·5	101
42*b*	695	?	—	—	—	177?	130	93	—	—	—	—	—	—	—	—	—
43	717	♀	1190	173	173	172	134	88	125	111·25	93	488·5	354	297	—	65	93
44	718	♂	1150	180	186·5	184	132	97	124·5	110·5	102	503	361	293	—	—	—
45	724	♀	1203	177·5	179	179	131	86	125·5	104·9	102·25	488	349	292	—	65	89·5
46	732	♀	1435	173	171	172·5	137·5	95	129·5	114·5	93·5	500	363	308	—	60·5	90
47	733	♀	—	176	173	173·5	127	84	127	113	94·5	486	356	297	—	—	—
48	749	♀?	1175	175	174	174	129·5	90	131	114·8	92 5	486	365	299	—	68	86
49	751	♀?	1276	181	179	181·2	127·5	88	130	113	97	502	365	295	108	65	96
50	751*a*	♀	1310	184	184?	183	134	86	128	113·75?	92	505	373	299	—	—	—
51	758	♂	—	—	198·5	—	—	96	—	120	107	534·5	394	310	—	70·75	102
52	801	♂	1310	177	178	178	132·5	90	130	114·5	102	498·5	363	300	116	69	97
53*a*	832	♂?	1210	181·5	180	181·5	134	89·5	133	115	99·5	507·5	370	301	110	65·5	95·5
53*b*	842	♀	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
54	844	♂	—	185·5	183	184	137·5	99	141·5	115	—	—	—	305	—	75	96
55*a*	862	♀?	1330	185	184	183	131·5	97	129	113	94	508	384	301	106·25	68	98
55*b*	864	♂	—	—	—	—	—	88	—	—	—	—	382?	—	—	—	—
56	867	♂?	1395?	184	186·5	185·5	144·6	93	131·5	121·8	—	512·5	380	321	—	—	—
57	871	♀?	—	—	—	195·5	139?	89	—	107 (*h*)	—	—	394	—	—	—	—
58	884	♀	1343	183·5	184·5	183·5	128·5	89·5	134	115·75	97·5	508	370	299	—	72	96

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69·25	97	122?	50·5	23	41	42·8	32·5	32	54·5	38?	78·8	74·2	78·8	74·2
67	100·25	—	50	25	41	40	34·75	35	51?	40	76·9	77·7	78·0	78·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	44	—	36	—	—	—	70·7	74·3	70·2	74·1
72·5	92	—	56·5	26	45·5	43·5	33·5	34·5	54·5	44·5?	73·7	68·7	73·9	68·9
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
58	79	—	49	27	38	38	33	31	45	42	—	—	—	—
71	—	—	49	25	—	39	—	32	48	44	—	—	80·3	75·0
—	—	—	—	—	—	—	—	—	—	—	74·5	72·3	73·7	71·5
—	—	—	—	—	—	—	—	—	—	—	—	—	73·9	71·0
—	—	—	—	—	—	—	—	—	—	—	74·7	—	72·7	—
60	89	—	42	24·5	42	43	32	31	53·5	34·5	77·1?	78·3?	75·7	76·9
—	—	—	—	—	—	—	—	—	—	—	—	—	74·9	—
—	—	—	—	—	—	—	—	—	—	—	74·4	74·9	—	—
59·75	85·5	—	46	22	38	37	30	29	52·5	36	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	78·0	67·8	78·4	68·2
69	98	143	51·3	25	48	47	35	35·5	59	40	72·2	71·6	72·5	72·0
68·5	—	—	48	22	—	39	—	33·5	49?	36?	—	—	76·2	74·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
67·5	90	—	49	23·75	41	43	32	31·5	51·5	36	68·3	70·4	69·0	71·2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
68·8	93	115?	49	26	41	39	32	32	60	43	72·4	72·7	72·6	72·9
64	89·5	121·75	47·5	27	42	42	31	31	58	38	76·7	69·1	76·7	69·1
—	—	—	—	—	—	—	—	—	—	—	—	—	73·4	—
—	—	—	—	—	—	—	—	—	—	—	—	—	75·6	70·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	74·2	71·5	73·6	71·0
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	75·4	75·7
—	—	—	—	—	—	—	—	—	—	—	67·5	69·6	67·5	69·6
69	104	—	52	25	42	—	32	—	55	46·5	73·8	72·0	73·4	72·6
61?	—	—	—	—	39·5	—	31	—	—	—	—	—	70·3	72·8
66·5	95·5	—	50·5	25·5	39·5	39·75	26·5	25	59	35	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	70·6	69·8	71·0	70·2
69·5	101	—	47·75	26	47	45	34·5	35	57	44	75·2	72·3	75·4	72·5
—	—	—	—	—	—	—	—	—	—	—	—	—	73·4?	—
65	93	124·6	45	24·5	42·25	42	32	31·8	—	—	77·5	72·3	77·9	72·7
—	—	—	—	—	—	—	—	—	—	—	70·8	66·2	71·7	67·7
65	89·5	116	46	20·5	40·75	41·75	31·5	31	56	32·3	73·2	70·1	73·2	70·1
60·5	90	—	47	24	38	39	33·5	32	45·5	36·5	80·4	75·7	79·7	75·1
—	—	—	—	—	—	—	—	—	—	—	73·4	73·4	73·1	73·2
68	86	114	50	22	40	41	33	32	51·5	38	74·4	75·3	74·4	75·3
65	96	120	46	25·5	42	41·5	32	30·5	54	44·5	71·2	72·6	70·4	71·7
—	—	—	—	—	—	—	—	—	—	—	72·8	69·6	73·2	69·9
70·75	102	131	51·5	26	44	42·5	31·5	31	64	46	—	—	—	—
69	97	—	48	26	43	43	31	31	59	40	74·4	73·0	74·4	73·
65·5	95·5	120?	46	26	45	44·75	31	32	54·5	39	74·4	73·9	73·8	73·3
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
75	96	—	53	24	44	44	34	34	—	—	75·1	77·3	74·7	76·9
68	98	122	48	25·5	40·5	41	29	29·75	52·8	38·75	71·5	70 1	72·0	70·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	77·5	70·5	78·0	70·9
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
72	96	—	52	26	49	48·5	37·5	37	50	37	69·6	72·6	70·0	73·0

rags. B' = 94·5.—86 parietals.—101 frags. of two crania.—108[b], 108[c], 118, 116, 140, 144, all frags.—201 frags. B'
istent front. sut.—502, 523, 525, 560, 594 *b* and *c*, 662, 683, 695 all frags.—712 frags. + broken frags. of ribs, vert

	Indices												Angles						Mandib	
G_2	B/L'	H/L'	B/L	H/L	B/H	GH/GB	$G'H/GB$	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	W_1	W_2
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	77·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	74·0	72·4	102·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	77·9	80·3	97·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
·5	78·1	74·7	77·8	74·5	104·5	—	63·2	51·1	78·6	76·6	81·0	83	68°·8	74°·6	36°·6	4°·9	31°·7	79°·5	—	—
—	—	—	72·9	70·8	95·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	73·9	70·3	73·9	70·3	105·1	—	66·0	54·3	81·8	78·7	80·0	99·25	73°·1	72°·2	34°·7	10°·05	24°·65	82°·25	—	—
—	—	—	70·5	73·4	96·1	—	—	—	—	—	—	93	—	—	—	—	—	83°·5	—	—
—	—	—	76·4?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	72·6?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
?	78·8	74·2	78·8	74·2	106·2	118·6	71·4	45·5	79·3	74·8	69·7	92·75	68°·1	75°·4	36°·5	8°·6	27°·9	84°	88	100
—	76·9	77·7	78·0	78·8	99·0	—	66·7	50·0	84·8	87·5	78·4	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	70·7	74·3	70·2	74·1	95·2	—	—	—	81·8	—	—	—	—	—	—	—	—	—	—	—
·5?	73·7	68·7	73·9	68·9	107·3	127·2?	78·8	46·0	73·6	79·3	81·7	93·5	64°·8	75°	40°·2	9°	31°·2	84°	105·75	120?
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	73·4	55·1	86·8	81·6	93·3	—	—	—	—	—	—	—	—	—
—	—	—	80·3	75·0	107·0	—	—	51·0	—	82·0	91·7	95·75	—	—	—	—	—	75°·5	98·75	106
—	74·5	72·3	73·7	71·5	103·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	73·9	71·0	104·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	74·7	—	72·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
·5	77·1?	78·3?	75·7	76·9	98·5	115·2	67·4	58·3	76·2	72·1	64·5	95·5	74°	73°·6	32°·4	7°·4	25°	81°	91	107?
—	—	—	74·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	74·4	74·9	—	—	99·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	69·9	47·8	78·9	78·3	68·6	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	78·0	67·8	78·4	68·2	115·0	—	—	—	—	—	—	—	—	—	—	—	—	—	93	118
—	72·2	71·6	72·5	72·0	100·7	—	70·4	48·7	72·9	75·5	67·8	97·5	59°·7	87°·6	32°·9	−3°·6	36°·3	84°	—	—
?	—	—	76·2	74·8	101·9	—	—	45·8	—	85·6	73·5	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	68·3	70·4	69·0	71·2	96·9	—	75·0	48·5	78·0	73·3	69·9	95·5	69°·9	76°·5	33°·6	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	72·4	72·7	72·6	72·9	99·6	—	74·0	53·1	78·0	82·1	71 7	—	—	—	—	—	—	—	—	—
—	76·7	69·1	76·7	69·1	111·0	118·4	71·5	56·8	73·8	73·8	65·5	95	75°·4	69°·4	35°·2	14°·77	20°·43	84°·17	177·75	112·25
—	—	—	73·4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	75·6	70·8	107·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	74·2	71·5	73·6	71·0	103·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	75·4	75·7	99·6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	67·5	69·6	67·5	69·6	97·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
·5	73·8	72·0	73·4	71·6	102·2	—	66·3	48·1	76·2	—	84·5	—	—	—	—	—	—	—	—	—
—	—	—	70·3	72·8	96·6	—	—	—	78·5	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	69·6	50·5	67·1	62·9	58·6	—	—	—	—	—	—	—	—	—
—	70·6	69·8	71·0	70·2	101·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	75·2	72·3	75·4	72·5	104·1	107·9	68·8	54·5	73·4	77·8	77·2	97	74°·7	70°·3	35°	13°·2	21°·8	83°·5	—	—
—	—	—	73·4?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	77·5	72·3	77·9	72·7	107·2	—	69·9	54·4	75·7	75·7	—	82	61°·1	82°	36°·9	6°·5	30°·4	88°·5	—	—
—	70·8	66·2	71·7	67·7	106·0	—	—	—	—	—	—	—	—	—	—	—	—	—	93	110?
3	73·2	70·1	73·2	70·1	104·4	—	72·6	44·6	77·3	74·2	57·7	92·5	56°	91°·8	32°·2	−4°·3	36°·5	87°·5	—	—
5	80·4	75·7	79·7	75·1	106·2	—	67·2	51·0	88·2	82·0	80·2	85·5	—	—	—	—	—	89°·5	—	—
—	73·4	73·4	73·1	73·2	100·0	—	—	—	—	—	—	—	—	—	—	—	—	—	71	88
—	74·4	75·3	74·4	75·3	98·9	—	79·1	44·0	82·5	78·0	73·8	82·25	61°·2	79°·7	39°·1	6°·3	32°·8	86°	—	—
5	71·2	72·6	70·4	71·7	98·1	112·5	67·7	55·4	76·2	73·5	82·4	94	70°·2	75°·7	34°·1	5°·3	28°·8	81°	84·25	104
—	72·8	69·6	73·2	69·9	104·7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	69·4	50·5	71·6	72·9	71·9	—	—	—	—	—	—	—	—	—
—	74·4	73·0	74·4	73·0	101·9	119·6	71·1	54·2	72·1	72·1	67·8	96	67°·1	77°·3	35°·6	8°·2	27°·4	85°·5	87·5	108
—	74·4	73·9	73·8	73·3	100·8	115·2	68·6	56·5	68·9	71·5	71·5	95	68°·9	77°·5	33°·6	9°·5	24°·1	87°	89·5	98·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	82	86
—	75·1	77·3	74·7	76·9	97·2	—	78·1	45·3	77·3	77·3	—	—	—	—	—	—	—	—	99?	—
75	71·5	70 1	72·0	70·5	101·9	108·4	69·4	53·1	71·6	72·6	73·4	86	64°·2	78°·9	36°·9	10°·1	26°·8	89°	94·5	106?
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	95	112·5
—	77·5	70·5	78·0	70·9	110·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	85?	—
—	69·6	72·6	70·0	73·0	95·9	—	75·0	50·0	76·5	76·3	74·0	92	65°·9	74°·9	39°·2	16°·1	23°·1	91°	—	—

144, all frags.—201 frags. $B'=86·5$.—212[a] frags. $B'=99$.—212[b] frags. $B'=91$.—217 frags.—279 frags. of several crania.—284 frags. of dome.—336, 339, 378
gs. + broken frags. of ribs, vertebrae and fingers.—708 *B* frags. $B'=93·5$.—711 frags. $B'=94$.—823 frags.—851 frags.

TABLE I.

Mandible				Remarks
W_1	W_2	h_1	f	
—	—	—	—	br. cr. ad. sut. closing
—	—	—	—	cal. – f. ad.
—	—	—	—	br. cal. – f. when br.?
—	—	—	—	br. cal. when br. ?
—	—	—	—	cr. ad.
—	—	—	—	cal. – f.
—	—	—	—	cr. ad. supraorb. foramen
—	—	—	—	cal. occipital and atlas fused
—	—	32	—	frags. of dome and m.
—	—	—	—	dome frags. ad. partly persist. front. sut.
88	100	33·75	44	cr. y. ad.
—	—	—	—	cal. ad.
—	—	—	—	frag. of dome
—	—	—	—	cal. – part f. adolesc.
105·75	120?	36·5	47	cr. ad. supraorb. foramina. small wormian b.
—	—	—	—	br. dome
—	—	—	—	badly br. cal.
98·75	106	32?	48	badly br. cr.
—	—	—	—	cal. – f. y. ad. interpar. and wormian bs.
—	—	—	—	cal. – f. ad.
—	—	—	—	br. dome old.
91	107?	30?	43	br. cr. ad.
—	—	—	—	cal. – f. ad.
—	—	—	—	dome badly br.
—	—	—	—	br. cal. [and sagit. suts. closed
—	—	—	—	dome v. asymmetrical s. interpar. b. coron.
93	118	32	43	cal. – f. + m. ad. coron. and sagit. suts. closed
—	—	—	—	cal. base br. ad. 3rd occipit. condyle
—	—	—	—	dome + frags. of f. y. ad.
—	—	—	—	br. dome
—	—	—	—	br. cal. adolesc.
—	—	—	—	br. cal. – f.
—	—	—	—	cal.
177·75	112·25	28	43·5	cr. ad.
—	—	—	—	dome ad.
—	—	—	—	cal. – f.
—	—	—	—	br. dome + frags. y. ad. asym. pariet.
—	—	—	—	br. cal. – f. ad.
—	—	—	—	frag. of dome + frontal
—	—	—	—	cal. – f. ad.
—	—	—	—	br. cal. – f.
—	—	—	—	cal. ad. ? m. curved dental arch
—	—	—	—	f. + frags. adolesc. supraorb. foram.
—	—	—	—	br. cal.
—	—	—	—	cal. + frags. of f. y. ad. pterion
—	—	34·5	—	cr. ad. supraorb. foram. persistent front. sut.
—	—	—	—	frags.
—	—	—	—	cal. old.
93	110?	33	—	cal. – f. y. ad. [and occipital
—	—	—	—	cal. y. ad. small wormian bs. between l. parietal
—	—	—	—	cal. y. ad. wormian bs. l. ant. condylar foram.
71	88	28	38	cal. – f. + m. adolesc. hair [fails
—	—	—	—	cal. y. ad.
84·25	104	30	43	cr. ad. hair
—	—	—	—	cal. – f. ad.
—	—	—	—	br. cal.
87·5	108	33	43·5	cr. ad.
89·5	98·5	32	43·5	cr. y. ad.
82	86	29	—	frags. y. ad.
99?	—	32?	—	frontals + parietals + frags.
94·5	106?	31·25	44·5	cr. ad.
95	112·5	29	45·5	frags. of cr. ad. wormian bs.
—	—	31	—	cal. – f. ad. inclined occipital
85?	—	31	46·5	cal. – f. + frags. + m. ad. [hair
—	—	—	—	cr. ad. small interpar. b. very l. styloid proc.

ne.—336, 339, 378, 388, 398 frags.—427 dome old.—436, 492 frags.—

				Lengths									Circumferences			Face				
Series No.	Grave No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*OH*	*LB*	*U*	*S*	*Q*	*GH*	*G'H*	*GB*	*J*	*NH*
59	1031	♀	1258	180·5	182·5	181	124·2	82	129	118	97	492·5	367	296	—	61·5	—	—	44
60	1037*a*	♂?	—	181	—	184	139	89	—	107 (*h*)	—	—	—	—	—	—	—	—	—
61	1037*b*	♀	—	181	—	180	137·5	—	—	—	—	—	—	—	—	—	—	—	—
62	1101	♀	1474	188	185	187·5	128	93	131	117·5	93	508	393·5	303	—	—	96	—	48
63	1102	♀	1523	185	185	185·5	136	91·5	135·5	120	99	515	387	311	104	62·5	95	124	46
64	1105	♀	1160	170	170·5	170	128·5	86	130	108	91·5	478	337·5	282	106·75	62·5	93	114	47
65*a*	1109	♀	—	181	182	181	135·5	93	134·5	114	93·5	511?	—	292	120	66·5	93·5	—	45
65*b*	1201	♀	—	—	—	—	—	93·5	—	—	—	—	—	—	—	62	88?	—	49
66	1212	♂	1271	175·5	182·5	179	138	101	128	115·5	102	502	350	308	—	72	107	—	50·5
67	1234*a*	♀	—	179	179	179	132	86	—	112	—	495	—	298	—	65	—	—	49·5
68	1300	♂?	1205?	180·5	182·5	182	132·8	87	126	119	95	494	358	306?	—	60·5	92·5	—	45
69	1307	♀?	—	175·5	174	175	128·5	88	124	108	95	487	351	280	—	—	—	—	—
70	1308	♀	1218	169	170	169·2	129	85	131	113·25	99	475	354	292	100	63	90·5	118	41
71*a*	1315	?	—	—	—	—	138	—	142	113 (*h*)	—	—	—	—	—	—	—	—	—
71*b*	1319	♂?	—	—	—	—	—	96	—	—	—	—	—	—	—	72·5	—	—	51
72	1329	♀	—	182	—	182	137	—	127	—	—	—	—	—	—	—	—	—	—
73	1335	♀	—	171	—	171	132	—	123	—	—	—	—	—	—	—	—	—	—
74	1336	♀?	—	184	—	183·5	126	—	—	—	—	—	—	—	—	—	—	—	—
75	1338	♀	1225	—	172	171	131	88	136	113	89	476·5	354	292	—	—	97·5	—	45
76	1338*a*	♀	—	—	—	184	125·8	—	—	—	—	—	—	—	—	—	—	—	—
77	1344	♀	—	168	170	167·5	126	81	125	107	—	478	344·5	288	—	62	92	111	46
78	1349	♂?	1373	180	181	181	138	84	129	115	92	501	374	298	103·75	60	91	113	47
79	1353	♀	—	178	—	177·5	125·5	90	127	—	96	—	360	—	—	60	95	—	44·5
80	1358	♂	1361	185	186	187	137	94	136·5	117	100	512	383	305	—	—	—	—	—
81	1358*a*	♀	—	184	184	184	125·8	92·5	—	114·5?	—	—	367	—	—	—	—	—	—
82	1383	♀	—	175	—	174·5	132	91·75	132·5	116	90	495	371	308?	—	—	—	—	—
83	1364	♀	1440	189	189	189	139·5	93	131	116	96	520	381	304	—	69?	93·5	—	52·7
84	1373	?	—	—	—	—	—	91	—	—	—	—	—	—	—	—	—	—	—
85	1376	♂	1419	187	188	187·5	136·5	89	134	113	100·5	516·5	371·5	298	103·5	61	92·75	—	46
86	1377	♂	1450	178	181	180·5	133	90	138	116·5	93·5	502·5	371·5	302	117	70	95	—	47·5
87	1379	♀?	—	—	188?	188	131	87·5	—	113 (*h*)	—	—	375	—	—	55·5	91	—	43
88	1392	♂	—	179·5	—	178	136·5	91·75	—	106 (*h*)	—	—	—	—	—	70	98·25	—	47·2
89	1398	♂?	1434	180·5	183	183·5	131	97	137	118	97	509	377	306	116·5	69·5?	97·5	120	48·7
90	1401	♀	—	—	182	—	—	90	—	116	99·5	—	371	—	—	—	—	—	—
91	1406	♂?	1149	170	171	169	126	85	124·5	110	92·75	470·5	344	285	—	58	90	119·5	41·5
92	1410	♀	1234	176·5	178	177·5	133	—	134	117	94·5	—	365	301	—	—	—	—	—
93*a*	1411	?	—	—	—	—	—	83	—	—	—	—	342?	—	—	—	—	—	—
93*b*	1412	♂	1365	173	175·5	174	135·5	88	126	111	101·5	495	353	303	112	65·5	92	—	50·5
94	1417*a*	♀	1200	168·5	169·5	169	131·5	84·5	128	111·75	101	470	346	295·5	—	—	—	122?	—
95	1419	♀	1268	176	175·5	174	131	93·6	127	109	92	494	356	298	—	—	—	—	—
96	1421	♂	1266	189	188	188·5	138·5	92	142	122	99·25	521	389	318	—	65	101	—	47
97	1422	♀	1300	170	171·5	171	137·5	90	133	115·75	97	483·5	359	300	—	69·5	94	120	50·5
98	1424	♀	—	177	176	176	133·5	93	124·5	115	97·75	—	356·5	304?	—	—	—	—	—
99	1441	♂	1454	187·5	186	188	134·5	86·5	138	120·5	99	512·5	375	307	—	66·5	98	117·5	44·5
100	1443	♂	—	188·5	190·5	188·5	128	88	—	114·25	—	515	380	297	—	—	—	—	—
101	1446	♂	1205?	—	174	172	129	86	134	108	88	479	363?	283	105·5	62	93	—	46
102	1452	♂	1400	180	185	183	133·5	85	134	112	98	496	366	297	—	69	87	123·5	52
103	1454	♂?	1120	176	180	178	125·25	89·5	132·25	108·25	95?	495	350?	278	—	—	—	—	—
104	1457	♀?	—	178·5	—	181	131·2	—	125	—	—	—	—	—	—	—	—	—	—
105	1459	♀?	1331	177	177	176	140	88	129	116	89	505	370	305	—	66	93	—	46
106	1461	♂?	—	195	—	193	141	94	—	109 (*h*)?	—	534	389	—	—	—	—	—	—
107	1469	♀	—	185	185·5	185·5	134	91·5	132	110·5	100	518	372·5	295	—	71	—	—	47
108	1474	♀	1344	180	180	180	134	91	130	112	103·5	502	363	295	—	—	—	—	—
109	1483	♂?	1376	176·5	179	178·5	134·5	91	137	117	99	497	360	310	114·75	69	97	120	50
110	1487	♀	1110	—	178?	175	120·5	88	133	113	100	—	—	292?	107·5	64·25	—	116?	45
111	1488	♀	—	173·5	—	175	137·8	—	131	—	—	—	—	—	108	—	—	—	—
112	1489	♂	1288	182	187·5	185	123·5	90·75	137·3	115	100	496	365	294	118	69·75	102	123·5	52
113	1494	♂	—	186·5	187·5	189	131·5	81	137·5	118·5	102·5	512	377	302	—	—	—	—	—
114	1499	♀	1440	184	179·5	182	135	92	138	113	98·5	509	377	302	—	69	—	—	47
115	1499*a*	♀?	1108	172·5	172	173·5	124	89	125	113	98	476	351	287	111	71·5	—	—	54

Miscellanea: 1047 frags.—1234[a] frags.—12

Face								Palate		Ini					
	J	*NH*	*NB*	*O*$_1$ *L*	*O*$_1$ *R*	*O*$_2$ *L*	*O*$_2$ *R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/G*
	—	44	25	—	38	—	29·5	58	38·5	68·1	70·7	68·6	71·3	96·3	—
	—	—	—	—	—	—	—	—	—	—	—	75·5	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	76·4	—	—	—
	—	48	25·75	44·5	45	33·5	34	—	38	69·2	70·8	68·3	69·9	97·7	—
	124	46	25	43	43·5	32	30·5	57	43	73·5	73·2	73·3	73·0	100·4	109·5
	114	47	22	44	44	34	34·75	50·5	39	75·4	76·2	75·1	76·5	98·8	114·8
5	—	45	24	44·25	43	30·5	31·5	56·5	40·5	74·4	73·9	74·9	74·3	100·7	128·2
?	—	49	24	—	—	31	—	47	35	—	—	—	—	—	—
	—	50·5	29	46	45	36·5	37·5	62	—	75·6	70·1	77·1	71·5	107·8	—
	—	49·5	24	—	39	—	28	—	37·5?	73·7	—	73·7	—	—	—
5	—	45	22	41	43	31	33	58	39	72·8	69·0	73·0	69·2	105·4	—
	—	—	—	—	—	—	—	—	—	73·9	71·3	73·4	70·9	103·6	—
5	118	41	24·5	36·5	35·5	27	27·25	52	35	75·9	77·1	76·2	77·4	98·5	110·5
	—	—	—	—	—	—	—	—	—	—	—	—	—	97·2	—
	—	51	24	42·5	43	31·5	34	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	75·3	69·8	107·9	—
	—	—	—	—	—	—	—	—	—	—	—	77·2	71·9	107·3	—
	—	—	—	—	—	—	—	—	—	—	—	68·7	—	—	—
·5	—	45	27	42	42	31	30·5	—	—	76·2	79·1	76·6	79·5	96·3	—
	—	—	—	—	—	—	—	—	—	—	—	68·4	—	—	—
	111	46	21	38	39	33·5	31·5	50	42·75	74·1	73·5	75·2	74·6	100·8	—
	113	47	25	44	44	32	33	55·5	37·75	76·2	71·3	76·2	71·3	107·0	114·0
	—	44·5	24	44	43·5	31	32	58	36·5	—	—	70·7	71·5	98·8	—
	—	—	—	—	—	—	—	—	—	73·7	73·4	73·3	73·0	100·4	—
	—	—	—	—	—	—	—	—	—	68·4	—	68·4	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	75·6	75·9	99·6	—
·5	—	52·75	23	44	—	35	—	57·5	36?	73·8	69·3	73·8	69·3	106·5	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
·75	—	46	23	45	44·5	29·5	30	—	37·75	72·6	71·3	72·8	71·5	101·9	111·6
5	—	47·5	23	39·5	41·5	31	32	56	43	73·5	76·2	73·7	76·5	96·4	123·2
1	—	43	23	38	37	33	32	—	—	69·7	—	69·7	—	—	—
8·25	—	47·25	25	41·75	40	32	30·5	63·5	44·6	—	—	76·7	—	—	—
7·5	120	48·75	30	44·5	44	32	31	56	38	71·6	74·9	71·4	74·7	95·6	119·5
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0	119·5	41·5	23·5	41	38	29·5	31	49	38·5	73·7	72·8	74·6	73·7	101·2	—
—	—	—	—	43·5	—	34·5	—	—	—	74·7	75·3	74·9	75·5	99·3	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2	—	50·5	22·5	40	39·5	33	32·5	56	39	77·2	71·8	77·9	72·4	107·5	110·9
—	122?	—	—	—	—	—	—	—	—	77·6	75·5	77·7	75·7	102·7	—
—	—	—	—	—	—	—	—	—	—	74·6	72·4	75·3	73·0	103·1	—
1	—	47	26	45	46·5	32	32·25	—	42·5	73·7	75·5	73·5	75·3	97·5	—
4	120	50·5	26·25	43	42·25	32·75	32	57	45	80·2	77·6	80·4	77·8	103·4	—
—	—	—	—	—	—	—	—	—	—	75·9	70·7	75·9	70·7	107·2	—
8	117·5	44·5	22·5	42·5	43·5	33	33·5	57·5	38	72·3	74·2	71·5	73·4	97·5	—
—	—	—	—	—	—	—	—	—	—	67·2	—	67·9	—	—	—
3	—	46	27·5	—	42	—	30·5	55	38	74·1	77·0	75·0	77·9	96·3	113·4
7	123·5	52	22	40	41·5	30·5	29·5	61	42	72·2	72·4	73·0	73·2	99·6	—
—	—	—	—	—	—	—	—	—	—	69·5	73·5	70·4	74·3	94·7	—
—	—	—	—	—	—	—	—	—	—	—	—	72·5	69·1	105·0	—
3	—	46	23	—	42·5	—	36	—	—	79·1	72·9	79·5	73·3	108·5	—
—	—	—	—	—	—	—	—	—	—	—	—	73·1	—	—	—
—	—	47	—	—	39·5	—	33·5	—	—	72·2	71·2	72·2	71·2	101·5	—
—	—	—	—	—	—	—	—	—	—	74·4	72·2	74·4	72·2	103·1	—
7	120	50	22	42	42	30·4	29·25	55	34?	75·1	76·5	75·3	76·8	98·2	118·3
—	116?	45	25	40·5	42	31	30	—	—	67·7	74·7	68·9	76·0	90·6	—
—	—	—	—	—	—	—	—	—	—	—	—	78·7	74·9	105·2	—
02	123·5	52·5	24	42	41·5	31·75	31	—	—	65·9	73·2	66·8	74·2	89·9	115·7
—	—	—	—	—	—	—	—	—	—	70·1	73·3	69·6	72·8	95·6	—
—	—	47	—	—	43	—	35	—	—	75·2	76·9	74·2	75·8	97·8	—
—	—	54	28	—	45	—	33·5	56	41	72·1	72·7	71·5	72·0	99·2	—

—1234[a] frags.—1251 frags.—1302 frag. $B'=91$.—1304 a frag.—1396 frags.—1417 two boxes of frags.—1413 fra

MEASUREMENTS OF NAQADA CRANIA—*continued.*

	O_1		O_2		Palate		Indices														
	L	R	L	R	G_1	G_2	B/L′	H/L′	B/L	H/L	B/H	GH/GB	G′H/GB	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	N∠	A∠	B
	—	38	—	29·5	58	38·5	68·1	70·7	68·6	71·3	96·3	—	—	56·8	—	77·6	66·4	97	73°·75	73°·75	32
	—	—	—	—	—	—	—	—	75·5	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	76·4	—	—	—	—	—	—	—	—	—	—	—	—
75	44·5	45	33·5	34	—	38	69·2	70·8	68·3	69·9	97·7	—	—	53·6	75·3	75·6	—	91·5	70°·2	72°·8	37
	43	43·5	32	30·5	57	43	73·5	73·2	73·3	73·0	100·4	109·5	65·8	54·3	74·4	70·1	75·4	99·75	74°·3	72°·7	33
	44	44	34	34·75	50·5	39	75·4	76·2	75·1	76·5	98·8	114·8	67·2	46·8	77·3	79·0	77·2	91·5	72°·2	72°	35
	44·25	43	30·5	31·5	56·5	40·5	74·4	73·9	74·9	74·3	100·7	128·3	71·1	53·3	68·9	73·3	71·7	—	—	—	—
	—	—	31	—	47	35	—	—	—	—	—	—	70·5	49·0	—	—	74·5	—	—	—	—
	46	45	36·5	37·5	62	—	75·6	70·1	77·1	71·5	107·8	—	67·3	41·4	79·3	83·3	—	99	69°·8	74°·6	35
	—	39	—	28	—	37·5?	73·7	—	73·7	—	—	—	—	43·5	—	71·8	—	—	—	—	—
	41	43	31	33	58	39	72·8	69·0	73·0	69·2	105·4	—	65·4	49·0	75·6	76·7	67·2	101	81°·5	68°	30
	—	—	—	—	—	—	73·9	71·3	73·4	70·9	103·6	—	—	—	—	—	—	—	—	—	—
5	36·5	35·5	27	27·25	52	35	75·9	77·1	76·2	77·4	98·5	110·5	68·5	59·8	74·0	76·8	67·3	97	73°·2	74°·8	32
	—	—	—	—	—	—	—	—	—	—	97·2	—	—	—	—	—	—	—	—	—	—
	42·5	43	31·5	34	—	—	—	—	—	—	—	—	—	47·0	74·1	79·1	—	—	—	—	—
	—	—	—	—	—	—	—	—	75·3	69·8	107·9	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	77·2	71·9	107·3	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	68·7	—	—	—	—	—	—	—	—	—	—	—	—
	42	42	31	30·5	—	-	76·2	79·1	76·6	79·5	96·3	—	—	60·0	73·8	72·6	—	92·5	77°·7	69°·8	32
	—	—	—	—	—	—	—	—	68·4	—	—	—	—	—	—	—	—	—	—	—	—
	38	39	33·5	31·5	50	42·75	74·1	73·5	75·2	74·6	100·8	—	67·4	45·7	88·2	80·8	85·5	—	—	—	—
	44	44	32	33	55·5	37·75	76·2	71·3	76·2	71·3	107·0	114·0	65·9	53·2	72·7	75·0	68·0	90·25	70°·8	73°·9	35
	44	43·5	31	32	58	36·5	—	—	70·7	71·5	98·8	—	63·2	53·7	70·5	73·6	62·9	—	—	—	—
	—	—	—	—	—	—	73·7	73·4	73·3	73·0	100·4	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	68·4	—	68·4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	75·6	75·9	99·6	—	—	—	—	—	—	—	—	—	—
	44	—	35	—	57·5	36?	73·8	69·3	73·8	69·3	106·5	—	73·8	43·6	79·5	—	62·6	97·5	72°·8	69°·9	37
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	45	44·5	29·5	30	—	37·75	72·6	71·3	72·8	71·5	101·9	111·6	65·8	50·0	65·6	67·4	—	97·5	71°·2	77°·3	31
	39·5	41·5	31	32	56	43	73·5	76·2	73·7	76·5	96·4	123·2	73·7	48·4	78·5	77·1	76·8	88·0	66°·6	76°·6	36
	38	37	33	32	—	—	69·7	—	69·7	—	—	—	61·0	53·5	86·9	86·5	—	—	—	—	—
	41·75	40	32	30·5	63·5	44·6	—	—	76·7	—	—	—	71·2	52·9	76·6	76·3	70·2	—	—	—	—
	44·5	44	32	31	56	38	71·6	74·9	71·4	74·7	95·6	119·5	71·3	61·5	71·9	70·5	67·9	91·75	68°·5	72°·7	38
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	41	38	29·5	31	49	38·5	73·7	72·8	74·6	73·7	101·2	—	64·4	56·6	72·0	81·6	78·6	87·5	68°·2	79°·7	32
	43·5	—	34·5	—	—	—	74·7	75·3	74·9	75·5	99·3	—	—	—	79·3	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	40	39·5	33	32·5	56	39	77·2	71·8	77·9	72·4	107·5	110·9	71·2	44·6	82·5	82·3	69·6	97	68°·8	76°·9	34
	—	—	—	—	—	—	77·6	75·5	77·7	75·7	102·7	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	74·6	72·4	75·3	73·0	103·1	—	—	—	—	—	—	—	—	—	—
	45	46·5	32	32 25	—	42·5	73·7	75·5	73·5	75·3	97·5	—	64·4	55·3	71·1	69·4	—	97·5	—	—	
25	43	42·25	32·75	32	57	45	80·2	77·6	80·4	77·8	103·4	—	73·9	52·0	76·2	76·2	78·9	92·5	67°·5	75°·4	37
	—	—	—	—	—	—	75·9	70·7	75·9	70·7	107·2	—	—	—	—	—	—	—	—	—	—
5	42·5	43·5	33	33·5	57 5	38	72·3	74·2	71·5	73·4	97·5	—	67·9	50·6	77·6	77·0	66·1	100·5	75°·2	71°·9	32
	—	—	—	—	—	—	67·2	—	67·9	—	—	—	—	—	—	—	—	—	—	—	—
5	—	42	—	30·5	55	38	74·1	77·0	75·0	77·9	96·3	113·4	66·7	59·8	—	72·6	69·1	87·25	71°	72°·2	36
	40	41·5	30·5	29·5	61	42	72·2	72·4	73·0	73·2	99·6	—	79·3	42·3	76·3	71·1	68·9	94	—	—	
	—	—	—	—	—	—	69·5	73·5	70·4	74·3	94·7	—	—	—	—	—	—	—	70°·4	71°·9	37
	—	—	—	—	—	—	—	—	72·5	69·1	105·0	—	—	—	—	—	—	—	—	—	—
	—	42·5	—	36	—	—	79·1	72·9	79·5	73·3	108·5	—	71·0	50·0	—	84·7	—	85	67°·2	74°·9	37
	—	—	—	—	—	—	—	—	73·1	—	—	—	—	—	—	—	—	—	—	—	—
	—	39·5	—	33·5	—	—	72·2	71·2	72·2	71·2	101·5	—	—	—	—	84·8	—	90·5	62°·9	80°·2	36
	—	—	—	—	—	—	74·4	72·2	74·4	72·2	103·1	—	—	—	—	—	—	—	—	—	—
	42	42	30·4	29·25	55	34?	75·1	76·5	75·3	76·8	98·2	118·3	71·1	44·0	72·4	69·7	61·8	90·5	64°	80°·1	35
	40·5	42	31	30	—	—	67·7	74·7	68·9	76·0	90·6	—	—	55·6	76·5	71·4	—	97·75	71°·9	75°·9	32
	—	—	—	—	—	—	—	—	78·7	74·9	105·2	—	—	—	—	—	—	88·75	—	—	—
	42	41·5	31·75	31	—	—	65·9	73·2	66·8	74·2	89·9	115·7	68·4	45·7	75·6	74·7	—	98	61°·4	80°·9	37
	—	—	—	—	—	—	70·1	73·3	69·6	72·8	95·6	—	—	—	—	—	—	—	—	—	—
	—	43	—	35	—	—	75·2	76·9	74·2	75·8	97·8	—	—	—	—	81·4	—	97	71°·6	73°·9	34
	—	45	—	33·5	56	41	72·1	72·7	71·5	72·0	99·2	—	—	51·9	—	74·4	73·2	91	65°·5	78°·4	36

1302 frag. $B'=91$.—1304 a frag.—1396 frags.—1417 two boxes of frags.—1413 frags.—1426 frags.—1451 br. cal. of child.—1460 frags.—1504 frags

TABLE II.

Angles						Mandible				Remarks
$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	W_1	W_2	h_f	f	
73°·75	73°·75	32°·5	9°	23°·5	82°·75	—	—	—	—	cal. y. ad.
—	—	—	—	—	—	—	—	—	—	dome, frags. of f. + m. pterion [on r.
—	—	—	—	—	—	—	—	—	—	cal. - f. wormian b. between pariet. and occip.
70°·2	72°·8	37°	13°·2	23°·8	86°	—	—	—	—	cal. ad.
74°·3	72°·7	33°	12°·3	20°·7	85°	91	117	30·5	45·5	cr. old, pterion, supraorb. foram.
72°·2	72°	35°·8	9°·75	26°·05	81°·75	92	109·5	31	43	cr. ad. pterion on r.
—	—	—	—	—	—	98	117·25	34·25	46	cal. + br. m. ad. hair
—	—	—	—	—	—	—	—	—	—	f. + frags. adolesc.
69°·8	74°·6	35°·6	7°·65	27°·95	82°·25	—	—	—	—	cal. old, suts. nearly gone
—	—	—	—	—	—	—	—	—	—	cal. + frags. of f. y. ad.
81°·5	68°	30°·5	14°·5	16°	82°·5	—	—	—	—	cal.: negroid, prognathous, lower margin nasal aperture rounded off, very small nasal spine, almost suppressed, flat nasal bone
—	—	—	—	—	—	—	—	—	—	cal. + frags. of f. adolesc. persist. front. sut.
73°·2	74°·8	32°	9°·45	22°·55	84°·25	85	106·75	29	43	cr. ad.
—	—	—	—	—	—	—	—	—	—	frags. without frontal, y. ad.
—	—	—	—	—	—	—	—	—	—	frags. + frags. of another skull, eyes remain
—	—	—	—	—	—	—	—	—	—	frags. of dome
—	—	—	—	—	—	—	—	—	—	frags. of dome
—	—	—	—	—	—	—	—	—	—	much br. cal. old, large interpar. b.
77°·7	69°·8	32°·5	9°·7	22°·8	79°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	br. dome
—	—	—	—	—	—	—	—	—	—	cal. - f. adolesc. hair
70°·8	73°·9	35°·3	7°·35	27°·95	81°·25	83·25	106	33	41	cr. ad. wormian bs. hair
—	—	—	—	—	—	—	—	—	—	br. cal.
—	—	—	—	—	—	—	—	—	—	br. cal.
—	—	—	—	—	—	—	—	—	—	dome y. ad.
—	—	—	—	—	—	90	106	30	—	cal. - f. + frags. ad.
72°·8	69°·9	37°·3	15°·1	22°·8	85°	—	—	—	—	cal. old, small wormian b.
—	—	—	—	—	—	—	—	—	—	br. dome
71°·2	77°·3	31°·5	5°·2	26°·3	82°·5	—	—	29·25	—	cr. + br. m., flattened at back
66°·6	76°·6	36°·8	7°·15	29°·65	83°·75	94·5	110·5	35	47	cr. ad. fused atlas, right only ankylosed,
—	—	—	—	—	—	—	—	—	—	br. cal. child [probably effect of disease
—	—	—	—	—	—	—	—	—	—	br. cal. ad.
68°·5	72°·7	38°·8	11°·8	27°	84°·5	93	101·75	31	41	cr. ad.
—	—	—	—	—	—	100	118·5	36	48	dome + m.
68°·2	79°·7	32°·1	8°·55	23°·55	88°·25	—	—	—	—	cr. adolesc.
—	—	—	—	—	—	95	116	30·5	44	cal. - part of f. ad. pterion, hair
—	—	—	—	—	—	—	—	—	—	frags.
68°·8	76°·9	34°·3	5°·6	28°·7	82°·5	102·5	—	33	43	cr. ad.
—	—	—	—	—	—	—	—	—	—	cal. - f. ad. supraorb. foram. injured frontal
—	—	—	—	—	—	—	—	—	—	cal. - parts of f. adolesc. interp. and wormian bs. persist. front. sut.
—	—	—	—	—	—	—	—	—	—	cal. ad. sagit. suts. largely closed
67°·5	75°·4	37°·1	8°·1	29°	83°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	m. br. cal. ad.
75°·2	71°·9	32°·9	7°·35	25°·55	79°·25	—	—	—	—	cal. old, sm. interp. b.
—	—	—	—	—	—	—	—	—	—	dome
71°	72°·2	36° 8	12°·8	24°	85°	85·25	108	30	42·5	cr. ad. union of atlas with occipital bone, secondary result of disease, interpar. and wormian bs.
—	—	—	—	—	—	—	—	—	—	cal. ad. curved dental arch
70°·4	71°·9	37°·7	13°·1	24°·6	85°	—	—	—	—	cal. - f. ad. irregul. wormian bs.
—	—	—	—	—	—	—	—	—	—	br. cal., when br.?
67°·2	74°·9	37°·9	18°·1	19°·8	93°	—	—	—	—	cal. ad. pterion, interp. b.
—	—	—	—	—	—	96	117·5	35·25	—	frags. of cal. + m. [some hair
62°·9	80°·2	36°·9	—	—	—	—	—	—	—	much br. cal. ad. place for extra r. molar,
—	—	—	—	—	—	95·75	101·5	35	43	cal. - f. + br. m. old
64°	80°·1	35°·9	2°·9	33°	83°	89·5	111	35	44	cr. br. f. pterion
71°·9	75°·9	32°·2	11°·1	21°·1	87°	78	96·5	32	44	cr. ad. hair, outgrowth
—	—	—	—	—	—	83·5	109·25	28·75	—	br. cal. - f. + m. when br.? persist. front. sut.
61°·4	80°·9	37°·7	4°·1	33°·6	85°	83?	102	31·25	41·5	cr. ad. [proc.
—	—	—	—	—	—	—	—	—	—	cal. - f. y. ad. supraorb. foram. long styloid
71°·6	73°·9	34°·5	10°·6	23°·9	84°·5	95·5	—	33·75	46	br. cal. + br. m. ad. hair
65°·5	78°·4	36°·1	3°·6	32°·5	82°	—	—	—	—	cr. old, l. side f. br.

frags.—1504 frags.

				Lengths								Circumferences			Fac				
Series No.	Grave No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*OH*	*LB*	*U*	*S*	*Q*	*GH*	*G'H*	*GB*	*J*	*NH*
116	1505	♀?	1380	186	185·5	184·5	133·5	86·5	129	114·75	93	505	379	293	—	73·75	95	117·5	51
117	1506	♂	—	—	187	185	140	100	138	116·25	102?	519·5?	369?	309	—	—	—	—	—
118	1507	♂	—	187	192·7	191	135	92	146	128?	109	521?	391	326?	—	—	—	—	—
119	1515	♀	1198?	178·5	179	178	122	82	129·5	113·5	92	491	366	285	—	—	—	—	—
120	1545	♂	1485	193	197	196·5	135	92	138	116	111	538	378	305	—	74?	99	131·5	52
121	1545*d*	♀	1303	180·5	181	182	131	89·5	127	110	101	497	357	294	—	66	91·5	—	47
122	1546	♂?	—	178	181?	181	135	83	139	124 (*h*)	102·5	506	363	—	114	69	92·5	127·75	51
123	1557	♀	—	—	—	—	—	85·5	—	—	—	—	—	—	—	71	97	—	51
124	1562	♂?	—	179·5	179	179	127	92	130·5	113	98·5	492·5	361	291	—	—	—	—	—
125	1586	♂	1305	179	179·5	180	130	94	141·5	120	100·5	498·5	370	309	—	64	96	129	46
126	1587	♂	—	—	185	—	—	84	—	110·5?	—	500?	361	288	—	—	—	—	—
127	1587·1	♂	1440	187	187	188	131·5	87·5	136	115·5	101·5	511	380	300	—	—	—	129·5	—
128	1587·3	♂	—	182	183·5	186	129	84·5	—	109	—	497	360	290	—	—	—	—	—
129	1587·4	♂	—	—	192	191	133	91	—	117	110?	518	370	297	—	—	—	130?	—
130	1592	♀?	—	—	—	179?	130?	93·5	—	112·5(*h*)	—	—	—	—	—	—	—	—	—
131	1594	♀	—	171	171·5	173	126	85·5	122·5	111	99	480?	339	298	—	—	—	—	—
132	1595	?	—	182	—	181	134	—	129	—	—	—	—	—	—	—	—	—	—
133	1604	♀	—	168	—	169	125	83·5	127	—	—	—	—	—	—	—	—	—	—
134	1607	♀	—	—	—	173	122	76	—	—	—	471?	352·5	—	—	65	88	—	45
135	1609	♂	—	193·5	191·5	191	137	99·5	—	124	105·5	524	—	316	116	70·5	106	129·5	50
136	1641	♂	1405	188	192	190	128·5	87·5	131	118	98·75	515	381	300	115·25	71·5	96	130	50
137	1643	♀	1301	184	182	183	129	85·5	131	113	95	500	371·5	291	—	73?	93	—	48
138	1644	♂	1365	182	183	184	131·5	91	132	116	96·75	503·5	370	300	—	64	96	—	46
139	1645	♂?	—	183	181·5	182	129	89	131	115·5	101	493	367	298	—	66	—	—	50
140	1647	♀	1463	188·5	188	187	133	95·25	138	122	102	514	379	314	107	70	95	—	51
141	1651	♂	1288	181·5	182	181	129·5	97	128	114	97·7	505	368	299	118·5	72	—	130	52
142	1653	?	—	—	—	—	132	—	—	114 (*h*)	—	—	—	—	—	—	—	—	—
143	1657	♂?	1443	—	184	183	133	85	137	113·5	98·5	504·5	369	300	—	68·5	91	120	47
144	1666	♀?	1299	188·5	190	189	130·7	90	138	121	106	516	381·5	303	—	70·5	100·75	115·75	46
145	1670	♀	1458	—	181·5	183	132·5	88	142	118	97	505	390	305	—	67	92·75	115	50
146	1672	♀	1375	—	181	182	130·75	87	135	110	99·75	490	369	289	120·5	70	90	113·5	46
147*a*	1673·2	♀	—	—	179	—	—	92	—	117	—	500	—	301	—	65	90·5	—	45
147*b*	1673·3	♀?	—	—	—	182?	122	85?	—	—	—	—	—	—	—	—	—	—	—
148*a*	1675	♂?	1338	—	187	183	125·5	93	134·5	116·5	103	504	366	297	109·75	64	105·5	124?	46
148*b*	1676*b*	♂?	—	—	—	181·5	131	89·5	—	—	—	503	375	—	—	—	—	—	—
149	1677	♂?	—	—	—	193·5	131	93	146	112 (*h*)	103	523?	385	—	—	72	—	136	53
150	1682	♂	—	—	—	—	—	84·5	—	116 (*h*)	108	—	360	—	—	—	—	—	—
151	1683	♂	1244	—	177	175	129·5	89	135	115·5	91	494	366	294	—	67	89·5	—	48
152	1684	♂	1554	—	188	190	137	91	143	119	102·5	523·5	384·5	309	—	75	95	131?	54
153	1690	♀	1340?	—	178·5	177	128·5	86	137	112	100	485	352·5	289	—	66·5	96·5	—	50
154	1709	♀	—	174	175·5	174·5	131·5	91	120·5	117·25?	95·5	487	352	284	—	—	—	—	—
155*a*	1715	♀	1330	—	173	171·5	139·5	85·5	128	112	82·5	490	365	304	—	65	89	—	44
155*b*	1729	♀	—	—	—	180?	136?	99	—	—	—	505?	—	—	—	72	90	—	46
156*a*	1733	♂	1440	—	179·5	177	135	92	138	115	89	503·5	366	305	113·75	70·25	91	126?	49
156*b*	1735	♀	—	—	—	169·5	123·5	91	—	98·5(*h*)	—	472	339	273	—	—	—	—	—
157	1739 below	♀	1183	171	169	170	122	82	128	111	94·5	470·5	352	288	—	65	96·5	112·5	46
158	1743	♀	1323	—	177	175	131	83	135·5	110·75	92	488·5	365	293	110	62	92	—	43
159	1745	♀	1288	182·5	180·5	182	123	87·5	129	114	95·25	494·5	365	280	—	—	—	—	—
160	1748	♂	1420?	—	187·5	184	131	96	137	115	99	512	374	304	—	67	91·5	—	48
161	1751 W	♀	1125	—	174	173·5	127·25	84	135	111·5	95	482	355	290	108	64	94·25	116	45
162	1751 E	♀?	1165	174	175	174	130·5	90·75	128	114	97	485·5	358	300	110	68	94	117	46
163	1753	?	—	170	—	168	121	—	—	—	—	—	—	—	—	—	—	—	—
164	1754	♀	1200	—	173	175	126	82	133	115·5	92	484	360	294	—	67	83	115·25	45
165	1755	♂	1413	—	186·5	185·5	133	102	139	121·5	100·3	517	375	312	120	70·75	100	130·3	53
166	1762	♂	—	—	195	191	131·5	95·5	145	113	109	524?	374	296	—	77·5	106	133·5	52
167	1773	♂	1490	184	186·5	184·5	136	97	133	120	90	519	376	314	—	68·5	—	—	49
168	1774	♀	1203	182	180	180	129	87·5	126·5	112	92	494	370·5	293·5	—	67	98·25	116	48
169	1775	?	—	167	—	165	117·5	79·5	—	—	—	—	—	—	—	57	87	—	41
170	1781	♂?	1450	188	187	187	132·5	89·5	132	119	94·5	513·5	387	310	108	63·5	93·5	121·5	45
171	1782*a*	♀	1190	—	171	169	127·5	80	128·5	114·5	89·5	477	355	295	—	65?	85	—	50
172*a*	1782*b*	♂	1423?	169·5	191	189	138	94	142	119	113·5	523·5	379·5	312·5	—	—	—	—	—
172*b*	1786	♂	—	—	—	181	—	97	—	—	—	—	369	—	—	68·5	105·5?	—	50
173	1787	♂?	1543	—	183	184	142	93·5	134	110·5	94·5	513·5	370	304	102	67	88	123·5	49

Miscellanea: 1515 two super. maxillae, 1608 frags. + hair.—1636 cal. old. par. sut. closed.—1648 frags.—1654 W. frag.—166

MEASUREMENTS OF NAQADA CRANIA—*continued.*

Face								Palate		Indic					
B	*J*	*NH*	*NB*	O_1 *L*	O_1 *R*	O_2 *L*	O_2 *R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/GB*
5	117·5	51	25	42·5	42	33·5	33	55	37	72·0	69·5	72·3	69·9	103·5	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	70·1	75·8	70·7	76·4	92·5	—
—	—	—	—	—	—	—	—	—	—	68·2	72·3	68·5	72·8	94·2	—
9	131·5	52·5	29	49	47	30	30	55	42·75	68·5	70·1	68·7	70·2	97·8	—
1·5	—	47	24	44	45	34·5	36	56·5	40·5	72·4	70·2	72·0	69·8	103·1	—
2·5	127·75	51	25	46·75	47	34	33	57·5	38	74·6	76·8	74·6	76·8	97·1	123·2
7	—	51	27	44·5	42·5	30	32	59·75	45	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	70·9	72·9	70·9	72·9	97·3	—
6	129	46·5	21·75	41·25	42	30·25	30·5	60	43	72·4	78·8	72·2	78·6	91·9	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	129·5	—	—	—	44	—	33	—	—	70·3	72·7	69·9	72·3	96·7	—
—	—	—	—	—	—	—	—	—	—	70·3	—	69·4	—	—	—
—	130?	—	—	—	—	—	—	—	—	69·3	—	69·6	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	72·6?	—	—	—
—	—	—	—	—	—	—	—	—	—	73·5	71·4	72·8	70·8	102·9	—
—	—	—	—	—	—	—	—	—	—	—	—	74·0	71·3	103·9	—
8	—	45·5	22·5	40	40	34·5	33·5	52	—	—	—	74·0	75·1	98·4	—
—	—	—	—	—	—	—	—	—	—	—	—	70·5	—	—	—
6	129·5	50	26	42·25	41·25	29·5	30·5	61?	47	71·5	—	71·7	—	—	109·4
6	130	50·25	24·5	44	43·5	35·75	34	56	36·5	66·9	68·2	67·6	68·9	98·1	120·1
3	—	48·75	25	44	—	36	35	64·75	40	70·9	72·0	70·5	71·6	98·5	—
6	—	46	26	47	40·5?	31	31	—	42	71·9	72·1	71·5	71·7	99·6	—
—	—	50	26·5	—	40·5	—	33	58	43	71·1	72·2	70·9	72·0	98·5	—
5	—	51	21	41	39	31·5	30·75	54·75	33	70·7	73·4	71·1	73·8	96·4	115·8
—	130	52	—	—	41·5	—	33·5	52	—	71·2	70·3	71·5	70·7	101·2	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1	120	47·75	23·5	40	40	29·5	29	51·75	35	72·3	74·5	72·7	74·9	97·1	—
0·75	115·75	46	26·5	43·5	43·5	33	32·75	56	47	68·8	72·6	69·2	73·0	94·7	—
2·75	115	50	25·8	38·5	39	30·5	31	57	37	73·0	78·2	72·4	77·6	93·3	—
0	113·5	46	24·25	38	41·5	33	31	62	34·5	72·2	74·6	71·8	74·2	96·8	133·9
0·5	—	45	23·5	42·5	42·5	32	31	52	37·5	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	67·0	—	—	—
5·5	124?	46	24·5	41	42·5	29·5	28	52	40	67·1	71·9	68·6	73·5	93·3	104·0
—	—	—	—	—	—	—	—	—	—	—	—	72·2	—	—	—
—	136	53	26	39	37	34	33	50	42?	—	—	67·7	75·5	89·7	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9·5	—	48·5	25	42·5	44	33	31	56	36	73·2	76·3	74·0	77·1	95·9	—
5	131?	54	27	45·75	46·5	34·75	33	56·5	—	72·9	76·1	72·1	75·3	95·8	—
6·5	—	50	25	46	44	34	33·5	53·5	38·5	72·0	76·8	72·6	77·4	93·8	—
—	—	—	—	—	—	—	—	—	—	74·9	68·7	75·4	69·1	109·1	—
9	—	44	22	39	39·5	32	29	50·5	38	80·6	74·0	81·3	74·6	109·0	—
0	—	46	26	43·5	45	37·5	37·5	55	38·5	—	—	75·6?	—	—	—
91	126?	49·5	23	42	41·75	32·5	32·5	50	39	75·2	76·9	76·3	77·9	97·8	125·0
—	—	—	—	—	—	—	—	—	—	—	—	72·9	—	—	—
6·5	112·5	46	22·5	38	38	28	28	51	37·5	72·2	75·7	71·8	75·3	95·3	—
92	—	43	22	43·5	42·5	32	31	48	32·5	74·0	76·6	74·9	77·4	96·7	119·6
—	—	—	—	—	—	—	—	—	—	68·1	71·5	67·6	70·9	95·3	—
91·5	—	48	24	41?	42	30·75	30	53·5	38	69·9	73·0	71·2	74·5	95·6	—
94·25	116	45	23	42·5	43·25	32·5	32·5	53·75	41·75	73·1	77·6	73·3	77·8	94·3	114·6
94	117	46	25	40	40	31	30	59	41·5	74·6	73·1	75·0	73·6	102·0	117·0
—	—	—	—	—	—	—	—	—	—	—	—	72·0	—	—	—
83	115·25	45	23·5	42·5	43·5	32	31	52	35	72·8	76·9	72·0	76·0	94·7	—
00	130·3	53	26·5	45	42·5	31·5	31	61	47·25	71·3	74·5	71·7	75·0	95·7	120·0
06	133·5	52	27	44	41·5	34	33	61	44	67·4	74·4	68·8	75·9	90·7	—
—	—	49	24	42	—	29	—	51	43	72·9	71·3	73·7	72·1	102·3	—
98·25	116	48	25	41·5	40·5	31·5	31	56	46	71·7	70·3	71·7	70·3	102·0	—
87	—	41	21	—	33?	—	32·5	38	28	—	—	71·2	—	—	—
93·5	121·5	45·5	24·5	42·5	43	30·5	29	56	37·5	70·9	70·6	70·9	70·6	100·4	115·5
85	—	50	21·5	41·5	38·5	33	36	—	—	74·6	75·1	75·4	76·0	99·2	—
—	—	—	—	—	—	—	—	—	—	72·3	74·3	73·0	75·1	97·2	—
05·5?	—	50	27	40	41	32·5	32	—	41	—	—	—	—	—	—
88	123·5	49	23	44	42·5	32·5	31·5	51	34·5	77·6	73·2	77·2	72·8	106·0	115·9

654 W. frag.—1669 frags. of dome.—1673 cal. in frags.—Another 1675 cal. – f. adolesc. persist. front. sut. worn

MEASUREMENTS OF NAQADA CRANIA—*continued.*

	O_1	O_2		Palate		Indices												Angles			
	R	L	R	G_1	G_2	B/L′	H/L′	B/L	H/L	B/H	GH/GB	G′H/GB	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	N∠	A∠	B∠	θ_2
5	42	33·5	33	55	37	72·0	69·5	72·3	69·9	103·5	—	77·4	49·0	78·8	78·6	67·3	91	69°	72°	39°	12°·1
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	70·1	75·8	70·7	76·4	92·5	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	68·2	72·3	68·5	72·8	94·2	—	—	—	—	—	—	—	—	—	—	—
	47	30	30	55	42·75	68·5	70·1	68·7	70·2	97·8	—	74·7	55·2	61·2	63·8	77·7	104·75	67°·6	78°·2	34°·2	6°·0
	45	34·5	36	56·5	40·5	72·4	70·2	72·0	69·8	103·1	—	72·1	51·1	78·4	80·0	71·7	98·75	70°·3	74°·4	35°·3	6°·6
75	47	34	33	57·5	38	74·6	76·8	74·6	76·8	97·1	123·2	74·6	49·0	72·7	70·2	66·1	—	—	—	—	—
5	42·5	30	32	59·75	45	—	—	—	—	—	—	73·2	52·9	67·4	75·3	75·3	—	—	—	—	—
	—	—	—	—	—	70·9	72·9	70·9	72·9	97·3	—	—	—	—	—	—	—	—	—	—	—
25	42	30·25	30·5	60	43	72·4	78·8	72·2	78·6	91·9	—	66·7	46·8	73·3	72·6	71·7	94	67°	79°·1	33°·9	9°·4
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	44	—	33	—	—	70·3	72·7	69·9	72·3	96·7	—	—	—	—	75·0	—	—	—	—	—	—
	—	—	—	—	—	70·3	—	69·4	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	69·3	—	69·6	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	72·6?	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	73·5	71·4	72·8	70·8	102·9	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	74·0	71·3	103·9	—	—	—	—	—	—	—	—	—	—	—
	40	34·5	33·5	52	—	—	—	74·0	75·1	98·4	—	73·9	49·5	86·3	83·8	—	—	—	—	—	—
	—	—	—	—	—	—	—	70·5	—	—	—	—	—	—	—	—	—	—	—	—	—
25	41·25	29·5	30·5	61?	47	71·5	—	71·7	—	—	109·4	66·5	52·0	69·8	73·9	77·0	—	—	—	—	—
	43·5	35·75	34	56	36·5	66·9	68·2	67·6	68·9	98·1	120·1	74·5	48·8	81·3	78·2	65·2	99·5	73°·2	71°·1	35°·7	9°·1
	—	36	35	64·75	40	70·9	72·0	70·5	71·6	98·5	—	78·5	51·3	81·8	—	61·8	97·5	73°·1	68°·7	38°·2	6°·0
	40·5?	31	31	—	42	71·9	72·1	71·5	71·7	99·6	—	66·7	66·5	66·0	76·5?	—	92·5	68°·8	76°·8	34°·4	5°·7
	40·5	—	33	58	43	71·1	72·2	70·9	72·0	98·5	—	—	53·0	—	81·5	74·1	96	68°·6	77°·9	33°·5	9°·1
	39	31·5	30·75	54·75	33	70·7	73·4	71·1	73·8	96·4	115·8	73·7	41·2	76·8	78·8	60·3	—	—	—	—	—
	41·5	—	33·5	52	—	71·2	70·3	71·5	70·7	101·2	—	—	—	—	80·7	—	98	71°	70°·3	38°·7	12°·7
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	40	29·5	29	51·75	35	72·3	74·5	72·7	74·9	97·1	—	75·3	49·2	73·8	72·5	67·6	91	65°·1	78°·5	36°·4	8°
	43·5	33	32·75	56	47	68·8	72·6	69·2	73·0	94·7	—	70·0	57·6	75·9	75·3	83·9	97·5	60°·1	87°·8	32°·1	−0°·3
	39	30·5	31	57	37	73·0	78·2	72·4	77·6	93·3	—	72·2	51·6	79·2	79·5	64·9	93·5	68°·8	74°·9	36°·3	7°·1
	41·5	33	31	62	34·5	72·2	74·6	71·8	74·2	96·8	133·9	77·8	52·7	86·8	74·7	55·6	92·25	65°·5	79°·1	35°·4	4°·9
	42·5	32	31	52	37·5	—	—	—	—	—	—	71·8	52·2	75·3	72·9	72·1	—	—	—	—	—
	—	—	—	—	—	—	—	67·0	—	—	—	—	—	—	—	—	—	—	—	—	—
	42·5	29·5	28	52	40	67·1	71·9	68·6	73·5	93·3	104·0	60·7	53·3	72·0	65·9	77·0	101·5	80°·4	67°·4	32°·2	21°·1
	—	—	—	—	—	—	—	72·2	—	—	—	—	—	—	—	—	—	—	—	—	—
	37	34	33	50	42?	—	—	67·7	75·5	89·7	—	—	49·0	87·2	89·2	84·0	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	44	33	31	56	36	73·2	76·3	74·0	77·1	95·9	—	74·9	51·5	77·6	70·5	65·2	99·75	80°·8	64°	35°·2	17°·7
5	46·5	34·75	33	56·5	—	72·9	76·1	72·1	75·3	95·8	—	78·9	50·0	75·9	71·0	—	101·25	69°·7	72°·9	37°·4	9°·1
	44	34	33·5	53·5	38·5	72·0	76·8	72·6	77·4	93·8	—	68·9	50·0	73·9	76·2	71·8	98	71°	74°·5	34°·5	7°·2
	—	—	—	—	—	74·9	68·7	75·4	69·1	109·1	—	—	—	—	—	—	96·5	—	—	—	—
	39·5	32	29	50·5	38	80·6	74·0	81·3	74·6	109·0	—	73·0	50·0	82·0	73·4	75·3	83·5	72°	69°·5	38°·5	12°·7
	45	37·5	37·5	55	38·5	—	—	75·6?	—	—	—	80·0	56·5	86·2	83·3	70·0	—	—	—	—	—
	41·75	32·5	32·5	50	39	75·2	76·9	76·3	77·9	97·8	125·0	77·2	46·5	77·4	77·8	78·0	90·5	71°·8	69°·3	38°·9	19°·7
	—	—	—	—	—	—	—	72·9	—	—	—	—	—	—	—	—	—	—	—	—	—
	38	28	28	51	37·5	72·2	75·7	71·8	75·3	95·3	—	67·4	48·7	73·7	73·7	73·5	93	71°	73°·6	35°·4	15°·4
	42·5	32	31	48	32·5	74·0	76·6	74·9	77·4	96·7	119·6	67·4	51·2	73·3	72·9	67·7	88	68°·3	76°·4	35°·3	7°·1
	—	—	—	—	—	68·1	71·5	67·6	70·9	95·3	—	—	—	—	—	—	—	—	—	—	—
	42	30·75	30	53·5	38	69·9	73·0	71·2	74·5	95·6	—	73·2	50·0	75·0	71·4	71·0	—	—	—	—	—
	43·25	32·5	32·5	53·75	41·75	73·1	77·6	73·3	77·8	94·3	114·6	67·9	51·1	76·5	75·1	77·7	91	69°·2	77°	33°·8	9°·5
	40	31	30	59	41·5	74·6	73·1	75·0	73·6	102·0	117·0	72·3	54·3	77·5	75·0	70·3	96	72°	73°·6	34°·4	6°·1
	—	—	—	—	—	—	—	72·0	—	—	—	—	—	—	—	—	—	—	—	—	—
	43·5	32	31	52	35	72·8	76·9	72·0	76·0	94·7	—	80·7	52·2	75·3	71·3	67·3	92·5	72°·6	71°·2	36°·2	10°·8
	42·5	31·5	31	61	47·25	71·3	74·5	71·7	75·0	95·7	120·0	70·8	50·0	70·0	72·9	77·4	94	66°·4	77°	36°·6	7°·2
	41·5	34	33	61	44	67·4	74·4	68·8	75·9	90·7	—	73·1	51·9	77·3	79·5	72·1	100·25	64°·5	78°·3	37°·2	10°·7
	—	29	—	51	43	72·9	71·3	73·7	72·1	102·3	—	—	49·0	69·0	—	84·3	95·5	75°·3	65°·8	38°·9	19°·4
	40·5	31·5	31	56	46	71·7	70·3	71·7	70·3	102·0	—	68·2	52·1	75·9	76·5	82·1	91	71°	72°·5	36°·5	9°
	33?	—	32·5	38	28	—	—	71·2	—	—	—	65·5	51·2	—	—	73·7	—	—	—	—	—
	43	30·5	29	56	37·5	70·9	70·6	70·9	70·6	100·4	115·5	67·9	53·8	71·8	67·4	67·0	92	70°	75°·5	34°·5	13°
	38·5	33	36	—	—	74·6	75·1	75·4	76·0	99·2	—	76·5	43·0	79·5	93·5	—	74	55°·5	84°	40°·5	4°·5
	—	—	—	—	—	72·3	74·3	73·0	75·1	97·2	—	—	—	—	—	—	—	—	—	—	—
	41	32·5	32	—	41	—	—	—	—	—	—	65·0?	54·0	81·2	78·1	—	—	—	—	—	—
	42·5	32·5	31·5	51	34·5	77·6	73·2	77·2	72·8	106·0	115·9	76·1	46·9	73·9	74·1	67·6	89·75	67°	75°·8	37°·2	9°·7

e.—1673 cal. in frags.—Another 1675 cal.—f. adolesc. persist. front. sut. worm. b. $L=179·5$, $B=132·5$, $B′=96$, $H=122$, $OH=110\,(h)$, $LB=96$, $U=504$

TABLE III.

Angles					Mandible				Remarks
∠	$B\angle$	θ_2	θ_1	$P\angle$	W_1	W_2	h_1	f	
°	39°	12°·17	26°·83	84°·17	—	—	—	—	cal. ad. v. flat occipital
—	—	—	—	—	—	—	27	47·5	cal. – f. + m. ad.
—	—	—	—	—	97	118	34	44·5	cal. – f. + m. ad.
—	—	—	—	—	—	—	—	—	cal. adolesc.
°·2	34°·2	6°·05	28°·15	84°·25	—	—	—	—	cr. – m. y. ad. supraorb. foram.
°·4	35°·3	6°·6	28°·7	81°	86	97	33	46	cr. ad. suts. oblit.
—	—	—	—	—	86·5	101	27	42	frags. of cr. ad. antral abscess.
—	—	—	—	—	87	106·5	32·5?	—	br. cr. ad. [incl. occip. scalp + hair
—	—	—	—	—	83	100?	30?	41	cal. – f. + br. m. ad. supraorb. foramina, v.
°·1	33°·9	9°·4	24°·5	88°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	br. dome + frags.
—	—	—	—	—	—	—	—	—	br. dome + frags. of f.
—	—	—	—	—	97	112	29	45	cal. – f. + m. [marked
—	—	—	—	—	110	125	33	48	cal. – f. + m. old. upper temporal lines very
—	—	—	—	—	—	—	33	41	dome + frags. ad. scalp + hair
—	—	—	—	—	82	107?	30·5	40	frags. of cal. – f. ad.
—	—	—	—	—	—	—	—	—	br. cal. when br.?
—	—	—	—	—	—	—	—	—	br. cal. old. hair
—	—	—	—	—	—	—	—	—	dome y. ad.
—	—	—	—	—	101	111	36	46	cr. ad. supraorb. foramina. all cervical vertebrae
°·1	35°·7	9°·15	26°·55	80°·25	91·5	110	33·5	43	cr. ad. sutures nearly closed
°·7	38°·2	6°·05	32°·15	74°·75	—	—	35	—	cal. + part of m. y. ad.
°·8	34°·4	5°·7	28°·7	82°·5	—	—	—	—	cal. y. ad.: curved dental arch associated with deep glenoid fossa and very prominent eminentia articularis. long hair
°·9	33°·5	9°·1	15°·1	87°	—	—	—	—	cal. br. f. ad.
—	—	—	—	—	88	117	31	44	br. cr. ad.
°·3	38°·7	12°·7	26°	83°	88	105	41·25	47·5	cr. br. f. ad. supraorb. foram.
—	—	—	—	—	84·75	102·75	37	—	dome + m. temp. bs. scalp + hair
°·5	36°·4	8°	28°·4	86°·5	—	—	—	—	cal. ad. supraorb. foram. curved dental arch
°·8	32°·1	−0°·3	32°·4	87°·5	—	—	37	—	cal. + frag. of m. old
°·9	36°·3	7°·1	29°·2	82°	—	—	—	—	cal. ad.
°·1	35°·4	4°·9	30°·5	84°	81	103	31·5	41	cr. ad.
—	—	—	—	—	80	95	25	40	br. cr. – frags. of f. etc. ad.
—	—	—	—	—	—	—	—	—	dome + frags. ad.
°·4	32°·2	21°·1	11°·1	88°·5	84·5	110·5	32	48	cr. ad. curved dental arch
—	—	—	—	—	—	—	—	—	cal. – f. + frags. ad. wormian b.
—	—	—	—	—	—	—	—	—	br. cal. ad.
—	—	—	—	—	91	109	30·5	—	frag. cal. + atlas verteb. + m.
°	35°·2	17°·75	17°·45	81°·75	86	105·5	28·5	43	cr. ad. wormian bs.
°·9	37°·4	9°·1	28°·3	82°	—	—	—	—	cal. ad.
°·5	34°·5	7°·25	27°·25	81°·75	—	—	—	—	cal. ad.
—	—	—	—	—	90	—	33	—	br. cr. child?, worn teeth
°·5	38°·5	12°·75	25°·75	82°·25	—	—	—	—	cal. ad. sm. wormian bs.
—	—	—	—	—	—	—	—	—	f. + frags. y. ad.
°·3	38°·9	19°·7	19°·2	89°	93	—	34·5	42·5	cr. ad.
—	—	—	—	—	—	—	—	—	dome + temp. bs. + frags. of f. adolesc.
°·6	35°·4	15°·4	20°	89°	—	—	—	—	cal. ad. supraorb. foramina
°·4	35°·3	7°·1	28°·2	83°·5	82·5	101	30·5	43	cr. ad.
—	—	—	—	—	81	108	33	—	cal. – f. ad. r. pterion. supraorb. foramina
—	—	—	—	—	93	110	37	42	br. cr. old, much inclin. occip. depression
°	33°·8	9°·5	24°·3	86°·5	87·5	106	31·5	41	cr. ad. [above λ.
°·6	34°·4	6°·15	28°·25	79°·75	80	101·5	33·5	41	cr. ad. teeth worn and distorted
—	—	—	—	—	—	—	—	—	frag.
°·2	36°·2	10°·8	25°·4	82°	—	—	—	—	cal. ad. pterion
°	36°·6	7°·25	29°·35	84°·25	102	117	33·25	45	cr. y. ad. persistent frontal sut.
°·3	37°·2	10°·7	26°·5	89°	—	—	—	—	cal. ad.
°·8	38°·9	19°·45	19°·45	85°·25	—	—	—	—	cal. old
°·5	36°·5	9°	27°·5	81°·5	—	—	—	—	cal. ad. sm. interpar. b. persist. frontal sut.
—	—	—	—	—	—	—	—	—	br. cal. child
°·5	34°·5	13°	21°·5	88°·5	82·75	102·75	33	41	cr. y. ad.
°	40°·5	4°·5	36°	88°·5	—	—	—	—	cal. deformed l. jugal
—	—	—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	—	—	cal. in frags. ad. nasal and other suts. closed
°·8	37°·2	9°·7	27°·5	85°·5	—	—	31	42	cr. br. m. ad. sm. wormian bs. between pariets.

$LB=96$, $U=504$, $S=361$, $Q=295$.—1677[b] dome + frags.—1680 cal. ad.—1734 frags.

				Lengths								Circumferences			Fa				
Series No.	Grave No.	Sex	*C*	*F*	*L'*	*L*	*B*	*B'*	*H*	*OH*	*LB*	*U*	*S*	*Q*	*GH*	*G'H*	*GB*	*J*	*NH*
174	1795	♂	—	—	187	185·5	140	96·5	139	120?	105	519	378	309	—	—	—	—	—
175	1796	♂	1320	—	182	184	131	92	139	115·6	99·6	501	364	299	126?	69·5	99	—	49·7
176	1799	♀	1268	—	173	174	126·5	86	141	115·25	94·5	481	353	298	—	58·5	84	112	44·5
177	1804*a*	♀	1272	167	167	166·5	134	89·75	132	114·75	90	479	350	300	—	—	94	—	43
178	1804*b*	♂?	1265?	—	178·5	180	126	95·5	137·75	110	94	493	362·5	291	107	60·75?	94·5	—	46
179	1806	♂	1520	—	188	183·5	138	95	142	119	93·5	518	385	310	—	66	90	—	48
180	1807	♀	1243	—	177·5	176·5	128	87	134	114	95·3	491?	364	296	—	—	—	—	—
181	1814 A	♂	1235?	—	175	174·5	124	78	142	116·5	97·75	473	355	291	—	65·5	—	—	50
182	1814 B	♀	1218	178	178	177·5	128·5	82	122·5	105	96	490	339	278	—	64·5	89·75	123·75	48
183	1816	♀	1225	180	180·5	180	131	93	128	110 25	96	501	359	286	—	68	98	123·5	49
184*a*	1820 E	♂	—	—	—	200	131·5	—	—	117 (*h*)	—	535	—	—	—	66·5	100·5	—	48
184*b*	1820 W	♀	1285	—	181	180	131	90	139	109·5	102·5	493	359	288	107	65·5	88?	—	50
185	1825	♀	1203	175	175·5	175	126	87	128	111·5	102	483·5	345	292	—	—	95	—	41
186	1827	♀	1189	183	181	182	128·3	84	129	112·5	91·75	498	371	288	—	69·5	91	114	49
187	1832	♀	—	—	179·5	178	134·5	88·5	127·5	108	—	494·5	—	298	112·5	70	97	120?	46·5
188	1860	♀?	—	176·5	176	177	130	82·5	130	114	93	490	371	296·5	—	—	—	113	—
189	1863	♀	1254	179	180	179	127·2	90·75	123·5	108·75	93	495	366·5	281	109	68·5	95·5	122·5	48·5
190	1875	♂	1286	—	177	179	134	80·5	135	112	98	491	351·5	293	115·25	68·5	105·5	125	50
191	1878*a*	♀	1311	177·5	176·5	175	134·5	85·5	133·5	115	94·5	492·5	368	304	—	—	90	—	44?
192	1878*b*	♂	1483?	—	186·5	185	130	84	144	114	98·5	511	383	298	—	67	90·5	—	47·75
193	1879	♂	1415	—	202	198·5	131·5	93·5	133·5	116	107	536	385·5	305	124	76	104	135·5	53
194	1884	♀	—	—	174	173·5	—	83	125·75	112	90	—	358	—	106·5	63	87·5	—	44·5
195	1890	♂	1418	186	187	187	136	81	137	117	99	506	379	306	—	73	97	125·5	56
196	1893	♂?	—	185·5	—	184	130·5	—	—	—	—	—	—	—	—	—	—	—	—
197	1899	♂	1306	181	180	181	133·7	91	132	116	95	509	370·5	303	—	72	95	125	53
198	1902	♀	1253	178	173	176·5	126	88·5	131	111	90	488	369	293·5	—	61	91	—	44·75
199*a*	1904*a*	♂	1394	184·5	183	183	135·6	94·5	131	110	96	514·25	371	298	—	71	100·25	118?	53
199*b*	1904*b*	♂?	—	—	—	180·5	—	91·5	—	—	—	—	—	—	—	70	95	—	52
200	1910	♀	1288	175	174	174·5	131	95	126	110	97	493?	344	287?	—	—	—	—	—
201	Q 9*a*	♀?	—	177	176	177	135·2	89·5	133	113	—	491	369	298	—	62	—	—	46·5
202	Q 9*b*	♀	—	169	171·5	170	124	84	128	106	—	476	355	280	—	63·5	89·5	—	47
203*a*	Q 13	♀	—	183	185	185	135	83	127?	111·5	—	504·5	375·5	296	—	—	—	—	—
203*b*	Q 18	?	—	—	—	201?	124	94	—	—	—	—	—	—	—	—	—	—	—
204	Q 30	♀	—	178	179·5?	176	135	98	—	114?	—	500	—	309?	—	—	—	—	—
205	Q 37	♂	—	199	—	199	—	99·5	145	113 (*h*)	—	—	405	327	—	—	—	—	—
206	Q 43	♂	—	—	—	192	130	93	—	—	—	—	—	—	—	—	—	—	—
207	Q 54	♀	1349	179	178	178·5	130·2	91	133·5	111·5	96·5	497·5	361	297·5	—	66	89	—	45
208	Q 59	♂	1340?	187·5	190	190·3	132·8	94·5	127·7	114	102·5	515·5	372	298	—	—	—	—	—
209	Q 59 (i)	♂	—	—	187	187	133	91	—	117·5?	—	511?	380?	312?	—	64	103	124·5	51
210	Q 82	♂	—	181	—	182·2	137	—	137	—	—	—	—	—	—	—	—	—	—
211*a*	Q 83	♂	1397	174·5	177	176	136	87	129	113·5	97	496	359	301	—	—	91	—	48·5
211*b*	Q 87	♂	—	—	—	185?	134	100?	—	95 (*h*)	—	—	—	—	—	—	—	—	—
212	Q 92½	♀	1146	167	169	168·1	134	84	124·1	110	84	476·75	—	294	—	60	90	118	40·75
213	Q 96	♂	—	191·5	195	194	139	93	—	121	—	534	—	312	—	—	—	—	—
214	Q 97	♂?	—	—	—	179·75	—	91	—	—	—	—	—	—	—	—	—	—	—
215	Q 103	♂	1241	174	175	174	126·5	84	134	113·75	93·5	489	365	287	—	62	94	120	46·5
216	Q 103½	♀?	1221	180	178	178	129·5	91·75	130	113	94	491	368	294	—	62·5	85?	121?	41
217	Q 105	♂?	1370?	172·5	172·5	172	135·5	88	132·8	114	101	495	359·5	305	—	57	96	124	45
218	Q 107*a*	♂	—	197	198·5	198·7	142·5	89	143	118	101	541?	404	312	—	—	97	130	48
219	Q 107*b*	?	—	—	—	—	—	—	—	103 (*h*)	—	—	—	—	—	—	—	—	—
220*a*	Q 107 well	♀?	—	183·2	182	183	132	90	125?	112	92?	501	—	285?	—	68·5	90	—	53
220*b*	Q 127	♀	—	—	—	—	—	95	—	—	—	—	—	—	—	72	105?	—	51
220*c*	Q 116	?	—	—	—	183	141	89	—	112 (*h*)	—	502	380	—	—	66·5	—	—	49
221	Q 131	♂	1493	194·5	198·5	198	132·5	90·5	134·5	115·75	103	536	393	294	—	71	94·5	124	46·5
222	Q 137	♂	1350	178·5	178	179	130·7	90·5	135	114	97	492·5	363·5	297	—	67·25	93	—	48·5
223	Q 144	♀	1415	183·5	183·5	183·5	136	92	134	110	97	509·5	382·5	302	—	54·5	92	—	46
224	Q 162*a*	♂	1549	188	189	188·5	136·5	91	140	119	107	520	382·5	315·5	—	63	96·25	128	47
225*a*	Q 162*b*	♂	—	196	—	195	140·5	—	139·5	—	—	—	—	—	—	—	—	—	—
225*b*	Q 162*c*	?	—	—	—	—	—	91	—	—	—	—	—	—	—	61	94	—	43
226	Q 171	♂	—	186	187	186	130·5	88·5	137	115	—	513	372	302	—	—	—	—	—

Miscellanea: 1817 dorsal vertebrae.—1901

MEASUREMENTS OF NAQADA CRANIA—c

Face								Palate							
	J	*NH*	*NB*	O_1 *L*	O_1 *R*	O_2 *L*	O_2 *R*	G_1	G_2	*B*/*L*′	*H*/*L*′	*B*/*L*	*H*/*L*	*B*/*H*	
	—	—	—	—	—	—	—	—	—	74·9	74·3	75·4	74·9	100·7	
	—	49·7	26	—	46	—	29	52·75	37·3	72·0	76·4	71·2	75·5	94·2	
	112	44·5	21·75	42·5	42·75	32·75	32·5	54	35·75	73·1	81·5	72·7	81·0	89·7	
	—	43	25	43·25	—	31·5	—	—	41·5	80·2	79·0	80·5	79·3	101·5	
5	—	46	20·5	44	42·5	34·5	32·5	53?	38?	70·6	77·2	70·0	76·5	91·5	
	—	48	26	44·25	42·5	32·5	32·5	56·5	34	73·4	75·5	75·2	77·4	97·2	
	—	—	—	—	—	—	—	—	—	72·1	75·5	72·5	75·9	95·5	
	—	50	23	—	44	—	33	58·5	37	70·9	81·1	71·0	81·4	87·3	
75	123·75	48	23	42·75	43·5	34	34	52·75	38·5	72·2	68·8	72·4	69·0	104·9	
	123·5	49	26·5	44	44	37·75	34·75	56·75	42	72·6	70·9	72·8	71·1	102·3	
5	—	48	28	42·5	43	32	32	50·5	—	—	—	65·7	—	—	
	—	50	25	—	42·5	—	35	61	44·5	72·4	76·8	72·8	77·2	94·2	
	—	41	25	41	39·5	31	29·5	—	38·5	71·8	72·9	72·0	73·1	98·4	
	114	49	24	41	40	33	32·5	53	35·75	70·9	71·3	70·5	70·9	99·4	
	120?	46·5	27	38	38·5	33	32·5	59	41·5	74·9	71·0	75·6	71·6	105·5	
	113	—	—	—	—	—	—	—	—	73·9	73·9	73·4	73·4	100·0	
5	122·5	48·5	26	40	41	32·5	31·5	58	36	70·7	68·6	71·1	69·0	103·0	
5	125	50	23·5	46	44·5	35	33·25	60	39·75	75·7	76·3	74·9	75·4	99·3	
	—	44?	24·5	40	39	30	29·5	—	—	76·2	75·6	76·9	76·3	100·7	
5	—	47·75	22	44	43	35	32·5	52·5	39	69·7	77·2	70·3	77·8	90·3	
	135·5	53	28	48·25	44·5	32	32·5	57	37	65·1	66·1	66·3	67·3	98·5	
5	—	44·5	24	39	39	29	28	48	36	—	72·3	—	72·5	—	
	125·5	56	25·5	40	40	30	29·5	57·5	46	72·7	73·3	72·7	73·3	99·3	
	—	—	—	—	—	—	—	—	—	—	—	70·9	—	—	
	125	53	27·75	43·5	41·5	32·75	32·5	62	39	74·3	73·3	73·9	72·9	101·3	
	—	44·75	22	41	42	33	34	55	43	72·8	75·7	71·4	74·2	96·2	
25	118?	53	25	45	46·5	37	36·5	58	44	74·1	71·6	74·1	71·6	104·3	
	—	52	23	41	44·5	34	34	45·5	39	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	75·3	72·4	75·1	72·2	104·0	

Q GRAVES

	—	46·5	24	38	—	30	—	50	37	76·8	75·6	76·4	75·1	101·7	
5	—	47	23	40·5	41	30	31·5	51·5	35	72·3	74·6	72·9	75·3	96·9	
	—	—	—	—	—	—	—	—	—	73·0	69·0	73·0	69·0	106·3	
	—	—	—	—	—	—	—	—	—	—	—	61·7?	—	—	
	—	—	—	—	—	—	—	—	—	75·2	—	76·7	—	—	
	—	—	—	—	—	—	—	54	40	—	—	—	72·9	—	
	—	—	—	—	—	—	—	—	—	—	—	67·7	—	—	
	—	45	23	44	44·5	33	—	53·5	36	73·1	75·0	72·9	74·8	97·5	
	—	—	—	—	—	—	—	—	—	69·9	67·2	69·8	67·1	104·0	
	124·5	51	25·75	42	42	30	29	57·5	44·4?	71·1	—	71·1	—	—	
	—	—	—	—	—	—	—	—	—	—	—	75·2	75·2	100·0	
	—	48·5	26	43	41·5	30·5	30·5	—	—	76·8	72·9	77·3	73·3	105·4	
	—	—	—	—	—	—	—	—	—	—	—	72·4	—	—	
	118	40·75	25	41	41	30·5	30·5	50·5	35·75	79·3	73·4	79·7	73·8	108·0	
	—	—	—	—	—	—	—	—	—	71·3	—	71·6	—	—	
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	120	46·5	25	45	43·5	34·5	34	51	38	72·3	76·6	72·7	77·0	94·4	
?	121?	41	22·5	43	43	31	31	51	36	72·8	73·0	72·8	73·0	99·6	
	124	45	23·75	38	39	30	29	52·5	46	78·6	77·0	78·8	77·2	102·0	
	130	48	29	45	43·5	33	32·5	50?	40·5	71·8	72·0	71·7	72·0	99·7	
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	—	53	25	44·5	43	31·5	33	—	—	72·5	68·7	72·1	68·3	105·6	
?	—	51	28	45	—	35	—	58	44	—	—	—	—	—	
	—	49	—	38	—	35	—	—	—	—	—	77·0	—	—	
5	124	46·5	28	43	42·5	34·5	32	59	34·5	66·8	67·8	66·9	67·9	98·5	
	—	48·5	25	43·5	42	32·75	33	59·5	37·5	73·4	75·8	73·0	75·5	96·8	
	—	46	27	40	41	30	30·5	—	—	74·1	73·0	74·1	73·0	101·5	
25	128	47	25	43	41	30	30	51	42	72·2	74·1	72·4	74·4	97·5	
	—	—	—	—	—	—	—	—	—	—	—	72·2	71·5	100·7	
	—	43	23	36	36·5	31	32	46	37	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	69·8	73·3	70·2	73·7	95·3	

vertebrae.—1901 br. dome + frags. of m.—Q 48 $B' = 94$.—Q 53 frags.—Q 63 $B' = 87$.—Q 68 frags.—Q

MEASUREMENTS OF NAQADA CRANIA—*continued.*

ACE					PALATE		INDICES													
NB	O_1 L	O_1 R	O_2 L	O_2 R	G_1	G_2	B/L′	H/L′	B/L	H/L	B/H	GH/GB	G′H/GB	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	N∠	A∠
—	—	—	—	—	—	—	74·9	74·3	75·4	74·9	100·7	—	—	—	—	—	—	—	—	—
26	—	46	—	29	52·75	37·3	72·0	76·4	71·2	75·5	94·2	127·3	70·2	52·3	—	63·0	70·7	99	71°·1	71°·
21·75	42·5	42·75	32·75	32·5	54	35·75	73·1	81·5	72·7	81·0	89·7	—	69·6	48·9	77·1	76·0	66·2	91	70°·1	77°·
25	43·25	—	31·5	—	—	41·5	80·2	79·0	80·5	79·3	101·5	--	—	58·1	72·8	—	—	85	67°·3	77°·
20·5	44	42·5	34·5	32·5	53?	38?	70·6	77·2	70·0	76·5	91·5	113·2	64·3	44·6	78·4	76·5	76·0	91	—	—
26	44·25	42·5	32·5	32·5	56·5	34	73·4	75·5	75·2	77·4	97·2	—	73·3	54·2	73·4	76·5	60·2	87	65°·4	77°·
—	—	—	—	—	—	—	72·1	75·5	72·5	75·9	95·5	—	—	—	—	—	—	—	—	—
23	—	44	—	33	58·5	37	70·9	81·1	71·0	81·4	87·3	—	—	46·0	—	75·0	63·3	92·5	—	—
23	42·75	43·5	34	34	52·75	38·5	72·2	68·8	72·4	69·0	104·9	—	72·0	47·9	79·5	78·2	73·0	93	69°·9	75°·
26·5	44	44	37·75	34·75	56·75	42	72·6	70·9	72·8	71·1	102·3	—	69·4	54·1	81·3	79·0	74·0	93	68°·9	73°·
28	42·5	43	32	32	50·5	—	—	—	65·7	—	—	—	61·2	58·3	75·3	74·4	—	—	—	—
25	—	42·5	—	35	61	44·5	72·4	76·8	72·8	77·2	94·2	121·6	74·4	50·0	—	82·4	73·0	94	65°·1	80°·
25	41	39·5	31	29·5	—	38·5	71·8	72·9	72·0	73·1	98·4	—	—	61·0	75·6	74·7	—	96	68°·6	81°·
24	41	40	33	32·5	53	35·75	70·9	71·3	70·5	70·9	99·4	—	76·4	49·0	80·5	81·3	67·5	91·5	71°	71°·
27	38	38·5	33	32·5	59	41·5	74·9	71·0	75·6	71·6	105·5	116·0	72·2	58·1	86·8	84·4	70·3	—	—	—
—	—	—	—	—	—	—	73·9	73·9	73·4	73·4	100·0	—	—	—	—	—	—	—	—	—
26	40	41	32·5	31·5	58	36	70·7	68·6	71·1	69·0	103·0	114·1	71·7	53·6	81·3	76·8	62·1	91·5	70°·3	73°
23·5	46	44·5	35	33·25	60	39·75	75·7	76·3	74·9	75·4	99·3	109·2	64·9	47·0	76·1	74·7	66·3	98	72°	71°·
24·5	40	39	30	29·5	—	—	76·2	75·6	76·9	76·3	100·7	—	—	55·7	75·0	75·6	—	97	73°·5	69°·
22	44	43	35	32·5	52·5	39	69·7	77·2	70·3	77·8	90·3	—	74·0	48·2	79·5	75·6	74·3	91·25	—	—
28	48·25	44·5	32	33·5	57	37	65·1	66·1	66·3	67·3	98·5	119·2	73·1	52·8	66·3	75·3	64·9	100·5	65°·5	78°
24	39	39	29	28	48	36	—	72·3	—	72·5	—	121·6	72·0	53·9	74·4	71·8	75·0	88·5	71°·3	74°·
25·5	40	40	30	29·5	57·5	46	72·7	73·3	72·7	73·3	99·3	—	75·3	45·5	75·0	73·8	80·0	97·5	69°·6	71°·
—	—	—	—	—	—	—	—	—	70·9	—	—	—	—	—	—	—	—	—	—	—
27·75	43·5	41·5	32·75	32·5	62	39	74·3	73·3	73·9	72·9	101·3	—	75·8	52·4	75·3	75·9	62·9	92·5	69°	73°
22	41	42	33	34	55	43	72·8	75·7	71·4	74·2	96·2	—	67·0	49·2	80·5	81·0	78·2	86·75	69°·2	76°
25	45	46·5	37	36·5	58	44	74·1	71·6	74·1	71·6	104·3	—	70·8	47·2	82·2	78·5	75·9	94·75	69°·2	71°·
23	41	44·5	34	34	45·5	39	—	—	—	—	—	—	73·7	44·2	82·9	76·4	85·7	—	—	—
—	—	—	—	—	—	—	75·3	72·4	75·1	72·2	104·0	—	—	—	—	—	—	—	—	—

Q GRAVES

24	38	—	30	—	50	37	76·8	75·6	76·4	75·1	101·7	—	—	51·6	78·9	—	74·0	89	—	—
23	40·5	41	30	31·5	51·5	35	72·3	74·6	72·9	75·3	96·9	—	70·9	48·9	74·1	76·8	67·9	—	—	—
—	—	—	—	—	—	—	73·0	69·0	73·0	69·0	106·3	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	61·7?	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	75·2	—	76·7	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	54	40	—	—	—	72·9	—	—	—	—	—	—	74·1	—	—	—
—	—	—	—	—	—	—	—	—	67·7	—	—	—	—	—	—	—	—	—	—	—
23	44	44·5	33	—	53·5	36	73·1	75·0	72·9	74·8	97·5	—	74·2	51·1	75·0	—	67·3	96	72°·3	73°·
—	—	—	—	—	—	—	69·9	67·2	69·8	67·1	104·0	—	—	—	—	—	—	—	—	—
25·75	42	42	30	29	57·5	44·4?	71·1	—	71·1	—	—	—	62·1	50·5	71·4	69·0	77·2	—	—	—
—	—	—	—	—	—	—	—	—	75·2	75·2	100·0	—	—	—	—	—	—	—	—	—
26	43	41·5	30·5	30·5	—	—	76·8	72·9	77·3	73·3	105·4	—	—	53·6	70·9	73·5	—	88·5	64°·2	80°·
—	—	—	—	—	—	—	—	—	72·4	—	—	—	—	—	—	—	—	—	—	—
25	41	41	30·5	30·5	50·5	35·75	79·3	73·4	79·7	73·8	108·0	—	66·7	61·3	74·4	74·4	70·8	85	73°·2	71°
—	—	—	—	—	—	—	71·3	—	71·6	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	45	43·5	34·5	34	51	38	72·3	76·6	72·7	77·0	94·4	—	66·0	53·8	76·7	78·2	74·5	95	74°	70°·
22·5	43	43	31	31	51	36	72·8	73·0	72·8	73·0	99·6	—	73·5	54·9	72·1	72·1	70·6	89·5	68°·4	77°·
23·75	38	39	30	29	52·5	46	78·6	77·0	78·8	77·2	102·0	—	59·4	52·8	78·9	74·4	87·6	95	68°·2	80°·
29	45	43·5	33	32·5	50?	40·5	71·8	72·0	71·7	72·0	99·7	—	—	60·4	73·3	74·7	—	99	71°·2	74°·
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	44·5	43	31·5	33	—	—	72·5	68·7	72·1	68·3	105·6	—	76·1	47·2	70·8	76·7	—	—	—	—
28	45	—	35	—	58	44	—	—	—	—	—	—	68·6	54·9	77·8	—	75·9	—	—	—
—	38	—	35	—	—	—	—	—	77·0	—	—	—	—	—	—	—	—	—	—	—
28	43	42·5	34·5	32	59	34·5	66·8	67·8	66·9	67·9	98·5	—	75·1	60·2	80·2	75·3	58·5	99·5	69°·6	75°·
25	43·5	42	32·75	33	59·5	37·5	73·4	75·8	73·0	75·5	96·8	—	72·3	51·5	75·3	78·6	63·0	100	75°·5	70°
27	40	41	30	30·5	—	—	74·1	73·0	74·1	73·0	101·5	—	59·2	58·7	75·0	74·4	—	89	65°·5	82°
25	43	41	30	30	51	42	72·2	74·1	72·4	74·4	97·5	—	65·5	53·2	69·8	73·2	82·4	99	66°·6	83°
—	—	—	—	—	—	—	—	—	72·2	71·5	100·7	—	—	—	—	—	—	—	—	—
23	36	36·5	31	32	46	37	—	—	—	—	—	—	64·9	53·5	86·1	87·6	80·4	—	—	—
—	—	—	—	—	—	—	69·8	73·3	70·2	73·7	95·3	—	—	—	—	—	—	—	—	—

br. dome + frags. of m.—Q 48 $B'=94$.—Q 53 frags.—Q 63 $B'=87$.—Q 68 frags.—Q 77 $B'=83$.—Q 116 frags.—Q 138 frags.—Q 148 frags.—Q 149 frag

TABLE IV.

GL	Angles						Mandible				Remarks
	$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	W_1	W_2	h_1	f	
—	—	—	—	—	—	—	—	—	—	—	cal. – f. ad.
9	71°·1	71°·9	37°	6°·1	30°·9	78°	98·75	—	38·25	46	cr. ad. supraorb. foramina, sm. interpar. b.
1	70°·1	77°·7	32°·2	8°·3	23°·9	86°	83	96	27?	41	cr. ad. g. develop. wormian bs. pterion
5	67°·3	77°·6	35°·1	10°·9	24°·2	88°·5	—	—	—	—	cal. ad. closed suts. [suture
1	—	—	—	—	—	—	89	108·5	34·5	41	br. cr. ad. pterion on both sides, persist. frontal
7	65°·4	77°·3	37°·3	11°·7	25°·6	89°	—	—	—	—	cr. ad.
—	—	—	—	—	—	—	—	—	—	—	br. cal.
2·5	—	—	—	—	—	87°	—	—	28	37·5	cr. old [ture to left
3	69°·9	75°·3	34°·8	7°·87	26°·93	83°·17	—	—	30	—	cal. + frag. m. adolesc. frontal sinus and aper-
3	68°·9	73°·9	37°·2	8°·1	29°·1	82°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	116·5	32	47	frags. of cr. large interpar. b.
4	65°·1	80°·8	34°·1	1°·95	32°·15	82°·75	89·5	107·5	31	37	cr. ad. pterion, abnormal teeth in l. jaw
6	68°·6	81°·5	29°·9	3°·5	26°·4	85°	—	—	—	—	cal. ad. r. pterion
1·5	71°	71°·1	37°·9	15°·65	23°·25	85°·75	—	—	—	—	cal. ad.
—	—	—	—	—	—	83°	90	106	32	44	cr. br. base, ad.
—	—	—	—	—	—	—	89·25	105	31·75	43	cr. and frags.
1·5	70°·3	73°	36°·7	11°	25°·7	84°	86·75	109	32	—	cr. ad. r. and l. pterion
8	72°	71°·8	36°·2	13°·2	23°	85°	97	112·5	35	45·5	cr. y. ad.
7	73°·5	69°·5	37°	13°·5	23°·5	83°	99	117	32	43·5	cr. old
1·25	—	—	—	—	—	—	—	—	—	—	cal. ad.
0·5	65°·5	78°	36°·5	16°	20°·5	94°	101	125	40·75	42·5	cr. old
8·5	71°·3	74°·5	34°·2	10°·75	23°·45	85°·25	80·5	98·5	31·5	41·5	br. cr. y. ad.
7·5	69°·6	71°·8	38°·6	11°·95	26°·65	83°·75	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	—	br. when?
2·5	69°	73°	38°	11°·17	26°·83	84°·17	—	—	—	—	cal. ad. supraorb. foramen
6·75	69°·2	76°	34°·8	7°·5	27°·3	83°·5	—	—	—	—	cal. ad. [bs.
4·75	69°·2	71°·5	39°·3	13°	26°·3	84°·5	—	—	—	—	cal. ad. two supraorb. foramina and wormian
—	—	—	—	—	—	—	—	—	—	—	f. + frags. supraorb. foramen
—	—	—	—	—	—	—	—	—	—	—	cal. – f. child.
9	—	—	—	—	—	86°	—	—	—	—	cal. ad. supraorb. foramen
—	—	—	—	—	—	—	—	—	—	—	br. cal.
—	—	—	—	—	—	—	—	—	—	—	cal. – f. pterion
—	—	—	—	—	—	—	—	—	—	—	scaphocephalic calvaria, abnormal
—	—	—	—	—	—	—	—	—	—	—	br. cal. – f. y. ad. small interpar. coronal
—	—	—	—	—	—	—	—	—	—	—	cal. + frags. of f. y. ad. [suture closed
—	—	—	—	—	—	—	—	—	—	—	br. dome
6	72°·3	73°·2	34°·5	9°·8	24°·7	83°	—	—	—	—	cal. ad. l. pterion
—	—	—	—	—	—	86°·5	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	—	br. when?
8·5	64°·2	80°·2	35°·6	—	—	—	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	—	frags. ad.
5	73°·2	71°	35°·8	9°·75	26°·05	80°·75	—	—	—	—	cr. ad. wormian bs. long styloid process
—	—	—	—	—	—	—	—	—	—	—	cal. – f. – b. ad. interparietal. inclined occipital
—	—	—	—	—	—	—	—	—	—	—	dome + frags.
5	74°	70°·8	35°·2	7°·7	27°·5	78°·5	—	—	—	—	cal. old abnorm. pterion
9·5	68°·4	77°·7	33°·9	10°·05	23°·85	87°·75	—	—	—	—	cal. ad.
5	68°·2	80°·4	31°·4	4°·6	26°·8	85°	—	—	—	—	cal. ad. wormian b.
9	71°·2	74°·6	34°·2	12°·15	22°·05	86°·75	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	—	frag.
—	—	—	—	—	—	—	—	—	—	—	br. cal. adolesc.?
—	—	—	—	—	—	—	—	—	—	—	br. cal. ad.
—	—	—	—	—	—	—	—	—	—	—	br. cal. old, sutures closed [obliterated
9·5	69°·6	75°·6	34°·8	7°·4	27°·4	83°	—	—	—	—	cal. old, coronal sut. interp. and occipit. sut.
0	75°·5	70°	34°·5	—	—	—	—	—	—	—	cal. ad.
9	65°·5	82°	32°·5	4°	28°·5	86°	—	—	—	—	cal. ad.
9	66°·6	83°	30°·4	1°·25	29°·15	84°·25	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	—	br. when?
—	—	—	—	—	—	—	—	—	—	—	frags. of cal.
—	—	—	—	—	—	—	—	—	—	—	frags. with a little hair

rags.—Q 149 frags.

				Lengths								Circumferences			Fa				
Series No.	Grave No.	Sex	C	F	L′	L	B	B′	H	OH	LB	U	S	Q	GH	G′H	GB	J	N
227	Q 173	♀?	1343	183	183	183·1	128·7	92	134	116	93	507	382	302	—	63	98	—	49
228	Q 174	♀?	—	181	—	180	128·5	85·5	—	98 (*h*)	—	495	365	284?	—	—	—	—	-
229	Q 176 B	♂	1313	176	178	178·8	131·6	83	133·5	115	101	505	364	294	—	—	—	—	-
230	Q 185	♀	—	185	186	185	132·5	90	—	117	—	512·5	377·5	305	—	—	—	—	-
231	Q 186	♀	—	—	—	—	—	—	—	97 (*h*)	—	—	—	—	—	—	—	—	-
232	Q 191	?	—	176·5	—	177	126	—	131	—	—	—	—	—	—	—	—	—	-
233	Q 208·3	♂	—	193·5	191	194·5	138·5	90·5	—	112	—	533	—	304	—	66	93	—	49
234	Q 210	♀?	—	183	182	182	—	83	135	119	100	—	380	313	—	68·5	95	122	45
235	Q 212·2	♀	—	172	171	170	119·5	86·75	—	107	—	474	—	274	—	57	88	—	39
236	Q 212·4	♀	1184	176·1	176	174	137·5	89	125	108	92·5	497	358	288	—	65·5	99	116·5	43
237*a*	Q 214	♀	—	173·5	—	172·5	137	—	—	105 (*h*)	—	—	—	—	—	—	—	—	-
237*b*	Q 215	♂	—	—	—	186	130·5	—	—	—	—	—	—	—	—	—	—	—	-
238	Q 217	♀	—	173·5	—	174	127·2	—	126	—	—	—	—	—	—	—	—	—	-
239	Q 225 E	♀?	1359?	184·3	183	182·8	137·6	88	133·2	120	89	510?	390·5	312?	—	—	—	—	-
240*a*	Q 225 W	♂	1310?	176·5	175	176·5	139·7	90	129	112	95·5	499·5	357	309	—	—	—	—	-
240*b*	Q 229	♂	—	—	—	173·5	127?	90	133	106 (*h*)?	102	477?	354	281?	—	—	—	—	-
241	Q 238	♀?	—	190	—	192	142·8	—	133·1	—	—	—	—	—	—	—	—	—	-
242	Q 241*a*	♀	1423	180	180	179·7	136·5	93·5	135	115	103	506	361·5	310	—	69	94	125·5	47
243*a*	Q 241*b*	♀	—	179·2	—	181·5	133·7	89	126·5	110 (*h*)	—	—	351	—	—	—	—	—	-
243*b*	Q 245	♂	—	—	—	182	130	93	—	—	—	481?	362?	—	—	—	—	—	-
244*a*	Q 252	♀	—	—	—	184	141?	90	—	107 (*h*)	—	510	375	—	—	66	86	—	47
244*b*	Q 254	♀	1295	177·5	179	177	127·6	89	128	113·5	96	492	357	290	—	67	90	117	47
245	Q 265	♀	—	180	180·5	181	125·5	83	130	115	—	488	374	291?	—	67·5	—	—	48
246	Q 272	♀?	1488	177	180	177·5	141	85	135·5	118·25	95	499	376·5	312	—	66	93	123	47
247	Q 276*a*	♀	1168	171·2	172·5	172·1	126·5	85·5	122	108·5	90	479	346	278	—	56?	85·5	—	42
248	Q 276*b*	?	—	—	—	177	131·5	85	—	—	—	—	362?	—	—	—	—	—	-
249	Q 299	♀?	1359	180	180	179	131·5	92·5	119	109	91	499·5	365	292	—	58	89	—	40
250	Q 305*a*	♂	1429	183·7	185	184	130	88·5	137	113·5	102	504·5?	377?	297	112·5	63	92·5	124·5	45
251	Q 305*b*	♀	1290?	176·8	176·5	176	135·6	83·5	124·1	109·75	90·5	493·5	362	292	—	66	90	117	49
252	Q 311	♀	1316	177	180	177·8	137·5	87	129·6	112·5	92	496·5	364	301	—	64·5?	88	118	48
253	Q 314	♀	—	180	—	178	130	87·5	131·5	—	—	—	373	—	—	56	81	—	41
254	Q 315	?	—	—	184·5	184	—	—	—	125·5	98·5	—	377·5	332	109·5	69·25	—	—	51
255	Q 321	♀?	1223	179	181	179	132	87·5	127	109·75	98	496?	361?	298?	—	75	104	121·5	52
256	Q 323	♂	—	190	190	—	—	90	—	117	100	519	390·5	298	—	—	—	—	-
257	Q 326 upper	♀	1223	181	180·5	179	131·4	86	128	117·75	96·75	488	377	308	—	68	94	113	46
258	Q 326 lower	♀	1315	182·7	185	184·5	128·5	89	123·5	110	93	501·5	367	286	—	73	99	113·5	49
259	Q 358·2	?	—	186·5	—	188·5	—	—	138·5	—	—	—	—	—	—	—	—	—	-
260	Q 359·2	♀	1235	169	170	169	128·2	87	132	113	97	481	348·5	294	—	—	—	—	-
261	Q 359·3	♂	1460	185	186	185·5	128·5	89·5	134	115·5	102	510	371	299	—	—	100	128	53
262	Q 365	♀	1415	182	184·5	182	135·5	90	132·5	120	96	509	370	312	—	64	95	—	44
263	Q 383	♂	1615	185	189	188·2	136·3	111	145	129	106	529?	391?	326?	—	—	—	—	-
264	Q 384	♀	1431	178	178	177·1	133	87	137	120	91	488·5	385	314	—	60	86	—	47
265	Q 392	♂	1438	184	187	187·4	132	97	138	117	105	513	379	301	—	60·5	104·5	(135?)	53
266*a*	Q 396	♂	—	187	186·5	186	134	88·5	138	117	100·5	513	375	304	—	—	—	—	-
266*b*	Q 398	♀	—	—	—	175	132	92	—	—	—	—	—	—	—	—	—	—	-
267	Q 400	♂	—	185	186·5?	188	142·5	95	142·5	124	102	523?	384?	320	—	—	—	—	-
268	Q 408*a*	♀	1305?	181·3	180	181·5	133·2	96·5	127·2	114	97·5	506	362	305	—	64	96	118	47
269	Q 408*b*	♂	—	189	186	188·2	129·6	92	135·8	119	103	509	373	304	—	69	87	124·5	52
270	Q 408*c*	♀	1303	179	179·5	180	128	89·5	127	114	91	497	366·5	294	—	59	96·5	125·5	44
271	Q 408*d*	♂	1310	178·2	178	178	129	86·5	125·5	109	87	484	364	291	—	63	86	114?	49
272	Q 408	♂?	1375	—	189	189	130	91	149	117·6	102·75	512	378·5	307	—	70	88	123	50
273	Q 411 (*a*)	♀	1158	170·2	173	171·2	132·6	89·5	121	110	91	482	350	295	—	61·5	92·25	121	47
274	Q 413	♀	—	—	—	—	—	—	—	116·5(*h*)	—	—	—	300	—	—	—	—	-
275	Q 420	♂	—	—	176	176	122	87·5	—	—	93·5	—	—	—	—	70·75	100	119	52
276*a*	Q 428	?	—	—	—	—	—	80·75	—	—	—	—	—	—	—	—	—	—	-
276*b*	Q 430	?	—	—	—	168?	131	90·5	—	—	—	—	—	—	—	64·5	—	—	49
277	Q 436	♀	—	176	176?	177	127	78	130·3	106 (*h*)	—	476	—	—	—	61	—	—	42
278	Q 437	♂	—	177	180	178	131·3	86	132	114·75	97·5	494·5	370	298	—	62·5	94·5	—	49
279	Q 438	♀	—	175	174	175	131·5	—	130	104	—	—	358	—	—	—	—	—	-
280	Q 445	♀?	1240	174	175·25	173	127	93	137	115	97·5	487	367	298	—	65	96·75	122	46
281	Q 466·3	♀?	1400	177	177	175·6	134·5	88	129·1	111	94	495	366	292	—	—	—	—	-
282	Q 466·4	♂	1260	185	187	186	125·8	85·5	131	114	94	503	381·5	291	—	—	97·5	—	45
283	Q 485 A	♀	1338	181·5	177	179·2	133·5	86	131·3	113	96	501	375	299	—	—	—	—	
284	Q 487	♀?	—	—	190	185	131	91	133	116·5?	108	509?	374·5?	307?	—	—	—	—	
285	Q 488	♀	—	177	—	177·5	135	90	132·5	—	—	—	—	—	—	—	—	—	

Miscellanea: Q 206 ♂ cal. – part of f. ad. covered with crystals

MEASUREMENTS OF NAQADA CRANIA—*continued.*

Face								Palate		Indices						
				O_1		O_2										
GB	*J*	*NH*	*NB*	*L*	*R*	*L*	*R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/GB*	*G'H/GB*
98	—	49	23	42·5	42	30·75	29·5	47	—	70·3	73·2	70·3	73·2	96·0	—	64·3
—	—	—	—	—	—	—	—	—	—	—	—	71·4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	73·9	75·0	73·6	74·7	98·6	—	—
—	—	—	—	—	—	—	—	—	—	71·2	—	71·6	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	71·2	74·0	96·2	—	—
93	—	49	25	44·5	—	34	—	—	—	72·5	—	71·2	—	—	—	71·0
95	122	45·5	28	42·5	41	29	29	57·5	38	—	74·2	—	74·2	—	—	72·1
88	—	39·5	25·5	39·5	37·5	33	34	45	34	69·9	—	70·3	—	—	—	64·8
99	116·5	43	27·5	45	45	31·5	31·5	54·5	39	78·1	71·0	79·0	71·8	110·0	—	66·2
—	—	—	—	—	—	—	—	—	—	—	—	79·4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	70·2	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	73·1	72·4	101·0	—	—
—	—	—	—	—	—	—	—	—	—	75·2	72·8	75·3	72·9	103·3	—	—
—	—	—	—	—	42·5	—	33	—	—	79·8	73·7	79·2	73·1	108·3	—	—
—	—	—	—	—	—	—	—	—	—	—	—	73·2?	76·7	95·5?	—	—
—	—	—	—	—	—	—	—	—	—	—	—	74·4	69·3	107·3	—	—
94	125·5	47·5	23	45·75	44·25	33·5	33·5	56	40	75·8	75·0	76·0	75·1	101·1	—	73·4
—	—	—	—	—	—	—	—	—	—	—	—	73·7	69·7	105·7	—	—
—	—	—	—	—	—	—	—	—	—	—	—	71·4	—	—	—	—
86	—	47	23	41	42	34	33	51	34	—	—	76·6?	—	—	—	76·7
90	117	47·5	23·75	42	39·5	33	33·5	52·5	38	71·3	71·5	72·1	72·3	99·7	—	74·4
—	—	48	24	—	41	—	33	48·75	38·5	69·5	72·0	69·2	71·8	96·5	—	—
93	123	47	24	40·5	39·5	30	28·5	56	41·5	78·3	75·3	79·4	76·3	104·1	—	71·0
85·5	—	42·5	21	39·25	39·5	32·75	33	47·75?	—	73·3	70·7	73·5	70·9	103·7	—	65·5
—	—	—	—	—	—	—	—	—	—	—	—	74·3	—	—	—	—
89	—	40	23	38·5	37·5	29·5	30	52	37·5	73·1	66·1	73·5	66·5	110·5	—	65·2
92·5	124·5	45·5	24·5	40	41	28·5	29	53	—	70·3	74·1	70·7	74·5	94·9	121·6	68·1
90	117	49·5	23	42·5	41·5	32·5	33·5	50·75	39·75	76·8	70·3	77·0	70·5	109·3	—	73·3
88	118	48	26	43	42	33·75	33	43·5?	35?	76·4	72·0	77·3	72·9	106·1	—	73·3
81	—	41	22	36·5	37	33	33	39	37	—	—	73·0	73·9	98·9	—	—
—	—	51	25	—	44	—	33	57·5	40	—	—	—	—	—	—	—
04	121·5	52·25	25	44	43	36	36	58	44	73·0	70·2	73·7	70·9	103·9	—	72·1
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
94	113	46·5	26	39	38·75	27·5	27·25	62	45	72·8	70·9	73·4	71·5	102·7	—	72·3
99	113·5	49·75	26·5	43	42	34·75	34·5	52·5	43	69·5	66·8	69·0	66·9	104·0	—	73·7
—	—	—	—	—	—	—	—	—	—	—	—	—	73·5	—	—	—
—	—	—	—	—	—	—	—	—	—	75·4	77·6	75·9	78·1	97·1	—	—
00	128	53·75	29	44·75	45·75	36·5	34	—	48	69·1	72·0	69·3	72·2	95·9	—	—
95	—	44·5	28·5	41·5	42·5	—	31	52	39·5	73·4	71·8	74·5	72·8	102·3	—	67·4
—	—	—	—	—	—	—	—	—	—	72·1	76·7	72·4	77·0	94·0	—	—
86	—	47	23·5	40	40·5	30	30·5	51	37	74·7	77·0	75·1	77·4	97·1	—	69·8
04·5	(135?)	53	30·5	42	41	33·5	33	54	41·5	70·6	73·8	70·4	73·6	95·7	—	57·9
—	—	—	—	—	—	—	—	—	—	71·8	74·0	72·0	74·2	97·1	—	—
—	—	—	—	—	—	—	—	—	—	—	—	75·4	—	—	—	—
—	—	—	—	—	—	—	—	—	—	76·4	76·4	75·8	75·8	100·0	—	—
96	118	47	25·5	45	44·5	38	37	53	42	74·0	70·7	73·4	70·1	104·7	—	66·7
87	124·5	52	24	40	41	36	36	45	41	—	—	68·9	72·2	94·7	—	79·3
96·5	125·5	44	29·25	43	42	30	31	55·5	40	71·3	70·8	71·1	70·6	100·8	—	61·1
86	114?	49	23·5	41·75	40·75	34	34·5	52·5	41·5	72·5	70·5	72·5	70·5	102·8	—	76·0
88	123	50	23·25	42	41	38	36·5	50	40	68·8	78·8	68·8	78·8	87·2	—	79·5
92·25	121	47	23	43	43	32	32	58	45	76·6	69·9	77·5	70·7	109·6	—	66·7
—	—	—	—	—	—	—	—	52·5	39	—	—	—	—	—	—	—
00	119	52	25·5	45	44	35	36·5	60	41	69·3	—	69·3	—	—	—	70·8
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	49	24·5	—	38?	34	34	44?	41	—	—	78·0?	—	—	—	—
—	—	42·5	—	—	40	—	28	—	—	72·2	74·0	71·8	73·6	97·5	—	—
94·5	—	49·5	25·75	42·5	39	24·75	27	56	38	72·9	73·3	73·8	74·2	99·5	—	66·1
—	—	—	—	—	—	—	—	—	—	75·6	74·7	75·1	74·3	101·2	—	—
96·75	122	46·5	24	41	38	29·5	30	52·5	35·5	72·5	78·2	73·4	79·2	92·7	—	67·2
—	—	—	—	—	—	—	—	—	—	76·0	72·9	76·6	73·5	104·2	—	—
97·5	—	45·5	27	44·5	43·5	30	29·5	—	42·5	67·3	70·1	67·6	70·4	96·0	—	—
—	—	—	—	—	—	—	—	—	—	75·4	74·2	74·5	73·3	101·7	—	—
—	—	—	—	—	—	—	—	—	—	69·0	70·0	70·8	71·9	98·4	—	—
—	—	—	—	—	—	—	—	—	—	—	—	76·1	74·6	101·9	—	—

ered with crystals and no measurements possible.—Q 212 frags. of two crania.—Q 230 frags. + mand. of child.—Q 251

MEASUREMENTS OF NAQADA CRANIA—*continued.*

					Palate		Indices														
NB	O_1 *L*	O_1 *R*	O_2 *L*	O_2 *R*	G_1	G_2	*B*/*L*′	*H*/*L*′	*B*/*L*	*H*/*L*	*E*/*H*	*GH*/*GB*	*G′H*/*GB*	*NB*/*NH*	O_2/O_1 *L*	O_2/O_1 *R*	G_2/G_1	*GL*	*N*∠	*A*∠	*B*
23	42·5	42	30·75	29·5	47	—	70·3	73·2	70·3	73·2	96·0	—	64·3	46·9	72·3	70·2	—	89	68°·1	75°	36
—	—	—	—	—	—	—	—	—	71·4	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	73·9	75·0	73·6	74·7	98·6	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	71·2	—	71·6	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	71·2	74·0	96·2	—	—	—	—	—	—	—	—	—	—
25	44·5	—	34	—	—	—	72·5	—	71·2	—	—	—	71·0	51·0	76·9	—	—	—	—	—	—
28	42·5	41	29	29	57·5	38	—	74·2	—	74·2	—	—	72·1	61·5	68·2	70·7	66·1	98·5	72°·3	75°	32
25·5	39·5	37·5	33	34	45	34	69·9	—	70·3	—	—	—	64·8	64·6	83·5	90·5	75·6	—	—	—	—
27·5	45	45	31·5	31·5	54·5	39	78·1	71·0	79·0	71·8	110·0	—	66·2	64·0	70·0	70·0	71·6	91	71°·8	74°·3	33
—	—	—	—	—	—	—	—	—	79·4	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	70·2	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	73·1	72·4	101·0	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	75·2	72·8	75·3	72·9	103·3	—	—	—	—	—	—	—	—	—	—
—	—	42·5	—	33	—	—	79·8	73·7	79·2	73·1	108·3	—	—	—	—	77·6	—	—	—	—	—
—	—	—	—	—	—	—	—	—	73·2?	76·7	95·5?	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	74·4	69·3	107·3	—	—	—	—	—	—	—	—	—	—
23	45·75	44·25	33·5	33·5	56	40	75·8	75·0	76·0	75·1	101·1	—	73·4	48·4	73·2	75·7	71·4	95	65°·5	80°·2	34
—	—	—	—	—	—	—	—	—	73·7	69·7	105·7	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	71·4	—	—	—	—	—	—	—	—	—	—	—	—
23	41	42	34	33	51	34	—	—	76·6?	—	—	—	76·7	48·9	83·0	78·5	66·7	—	—	—	—
23·75	42	39·5	33	33·5	52·5	38	71·3	71·5	72·1	72·3	99·7	—	74·4	50·0	78·6	84·8	72·4	94·25	71°	73°·8	35
24	—	41	—	33	48·75	38·5	69·5	72·0	69·2	71·8	96·5	—	—	50·0	—	80·5	79·0	89?	—	—	—
24	40·5	39·5	30	28·5	56	41·5	78·3	75·3	79·4	76·3	104·1	—	71·0	51·1	74·1	72·2	74·1	92	69°·9	75°·1	35
21	39·25	39·5	32·75	33	47·75?	—	73·3	70·7	73·5	70·9	103·7	—	65·5	49·4	83·4	83·5	—	85	68°·8	80°·2	31
—	—	—	—	—	—	—	—	—	74·3	—	—	—	—	—	—	—	—	—	—	—	—
23	38·5	37·5	29·5	30	52	37·5	73·1	66·1	73·5	66·5	110·5	—	65·2	57·5	76·6	80·0	72·1	88	70°·8	76°·9	32
24·5	40	41	28·5	29	53	—	70·3	74·1	70·7	74·5	94·9	121·6	68·1	53·8	71·3	70·7	—	93	64°·8	82°·9	32
23	42·5	41·5	32·5	33·5	50·75	39·75	76·8	70·3	77·0	70·5	109·3	—	73·3	46·1	76·5	80·7	78·3	88·75	69°·1	72°·3	38
26	43	42	33·75	33	43·5?	35?	76·4	72·0	77·3	72·9	106·1	—	73·3	54·2	78·5	78·6	80·5	89	69°·1	74°·4	36
22	36·5	37	33	33	39	37	—	—	73·0	73·9	98·9	—	—	—	—	—	—	—	—	—	—
25	—	44	—	33	57·5	40	—	—	—	—	—	—	—	49·0	—	75·0	69·6	—	—	—	—
25	44	43	36	36	58	44	73·0	70·2	73·7	70·9	103·9	—	72·1	47·8	81·8	83·7	74·1	95·5	69°	72°·8	38
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
26	39	38·75	27·5	27·25	62	45	72·8	70·9	73·4	71·5	102·7	—	72·3	55·9	70·5	70·3	72·6	93·25	69°·1	75°·1	35
26·5	43	42	34·75	34·5	52·5	43	69·5	66·8	69·0	66·9	104·0	—	73·7	53·3	80·8	82·1	81·9	90	67°·5	72°·5	40
—	—	—	—	—	—	—	—	—	—	73·5	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	75·4	77·6	75·9	78·1	97·1	—	—	—	—	—	—	—	—	—	—
29	44·75	45·75	36·5	34	—	48	69·1	72·0	69·3	72·2	95·9	—	—	53·2	81·6	74·3	—	93	64°·2	80°·2	35
28·5	41·5	42·5	—	31	52	39·5	73·4	71·8	74·5	72·8	102·3	—	67·4	64·0	—	72·9	76·0	93	70°·3	76°·9	32
—	—	—	—	—	—	—	72·1	76·7	72·4	77·0	94·0	—	—	—	—	—	—	—	—	—	—
23·5	40	40·5	30	30·5	51	37	74·7	77·0	75·1	77·4	97·1	—	69·8	50·0	75·0	75·3	72·5	92	74°·7	72°	33
30·5	42	41	33·5	33	54	41·5	70·6	73·8	70·4	73·6	95·7	—	57·9	57·5	79·8	80·5	76·8	100·5	—	—	—
—	—	—	—	—	—	—	71·8	74·0	72·0	74·2	97·1	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	75·4	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	76·4	76·4	75·8	75·8	100·0	—	—	—	—	—	—	—	—	—	—
25·5	45	44·5	38	37	53	42	74·0	70·7	73·4	70·1	104·7	—	66·7	54·3	84·4	83·1	79·2	—	—	—	—
24	40	41	36	36	45	41	—	—	68·9	72·2	94·7	—	79·3	46·2	90·0	87·8	91·1	88·75	—	—	—
29·25	43	42	30	31	55·5	40	71·3	70·8	71·1	70·6	100·8	—	61·1	66·5	69·8	73·8	72·1	—	—	—	—
23·5	41·75	40·75	34	34·5	52·5	41·5	72·5	70·5	72·5	70·5	102·8	—	76·0	48·0	81·4	84·7	79·0	86	71°·3	72°·9	35
23·25	42	41	38	36·5	50	40	68·8	78·8	68·8	78·8	87·2	—	79·5	46·5	90·5	89·0	80·0	93·25	65°	84°	31
23	43	43	32	32	58	45	76·6	69·9	77·5	70·7	109·6	—	66·7	48·9	74·4	74·4	77·6	90·5	72°·4	73°·1	34
—	—	—	—	—	52·5	39	—	—	—	—	—	—	—	—	—	—	74·3	—	—	—	—
25·5	45	44	35	36·5	60	41	69·3	—	69·3	—	—	—	70·8	49·0	77·8	83·0	68·3	99	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
24·5	—	38?	34	34	44?	41	—	—	78·0?	—	—	—	—	50·0	—	—	—	—	—	—	—
—	—	40	—	28	—	—	72·2	74·0	71·8	73·6	97·5	—	—	—	—	70·0	—	—	—	—	—
25·75	42·5	39	24·75	27	56	38	72·9	73·3	73·8	74·2	99·5	—	66·1	52·0	58·2	69·2	68·0	88	63°·5	82°·1	34
—	—	—	—	—	—	—	75·6	74·7	75·1	74·3	101·2	—	—	—	—	—	—	—	—	—	—
24	41	38	29·5	30	52·5	35·5	72·5	78·2	73·4	79·2	92·7	—	67·2	51·6	72·0	78·9	67·6	90·75	66°·2	79°·7	34
—	—	—	—	—	—	—	76·0	72·9	76·6	73·5	104·2	—	—	—	—	—	—	—	—	—	—
27	44·5	43·5	30	29·5	—	42·5	67·3	70·1	67·6	70·4	96·0	—	—	59·3	67·4	67·8	—	91·5	70°	74°·7	35
—	—	—	—	—	—	—	75·4	74·2	74·5	73·3	101·7	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	69·0	70·0	70·8	71·9	98·4	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	76·1	74·6	101·9	—	—	—	—	—	—	—	—	—	—

l no measurements possible.—Q 212 frags. of two crania.—Q 230 frags. + maud. of child.—Q 251 frags.—Q 260 frags.—Q 264 frags.—Q 334 frags.—Q 364

TABLE V.

Angles						Mandible				Remarks
$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	W_1	W_2	h_1	f	
68°·1	75°	36°·9	10°·5	26°·4	85°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	dome + frag. ad.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	—	—	—	br. cal. – f. old
—	—	—	—	—	—	—	—	—	—	frags. dome
—	—	—	—	—	—	—	—	—	—	frags. br. cal. when br.?
—	—	—	—	—	—	—	—	—	—	cal. – f. ad.
72°·3	75°	32°·7	10°	22°·7	85°	—	—	—	—	br. cal. y. ad. [persist. front. sut.
—	—	—	—	—	—	—	—	—	—	cr. – occipit. y. ad. wormian and interpar. bs.
71°·8	74°·3	33°·9	11°·2	22°·7	85°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	dome. hair
—	—	—	—	—	—	—	—	—	—	dome + frags. y. ad.
—	—	—	—	—	—	—	—	—	—	frags.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad. [foram.
—	—	—	—	—	—	—	—	—	—	cal. – part of f. ad. small interpar. b. supraorb.
—	—	—	—	—	—	—	—	—	—	br. cal – f. ad. asymet. large interpar. b.
—	—	—	—	—	—	—	—	—	—	back of skull + frags. ad.
65°·5	80°·2	34°·3	6°·3	28°	86°·5	—	—	—	—	cal. ad. pterion
—	—	—	—	—	—	—	—	—	—	br. cal. – f. ad.
—	—	—	—	—	—	—	—	—	—	br. dome + crystallised frags.
—	—	—	—	—	—	—	—	—	—	br. cal. ad.
71°	73°·8	35°·2	13°·2	22°	87°	—	—	—	—	cal. ad.
—	—	—	—	—	86°	—	—	—	—	br. cal. ad. supraorb. foramina
69°·9	75°·1	35°	6°·4	28°·6	81°·5	—	—	—	—	cal. ad.
68°·8	80°·2	31°	4°·8	26°·2	85°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	frags. golden (artificially coloured?) hair
70°·8	76°·9	32°·3	5°·1	27°·2	82°	—	—	—	—	cal. br. f. adolesc. persist. front. sut.
64°·8	82°·9	32°·3	1°·1	31°·2	84°	100·5	—	30·5	50	cr. ad. portions of scalp; abnorm. jugal.
69°·1	72°·3	38°·6	17°·7	20°·9	90°	—	—	—	—	cal. ad. supraorb. foram.
69°·1	74°·4	36°·5	13°·6	22°·9	88°	—	—	—	—	cal. y. ad. supraorb. foramen
—	—	—	—	—	—	—	—	—	—	cal. adolesc.
—	—	—	—	—	—	—	—	—	—	cal. – parts of f. ad.
69°	72°·8	38°·2	8°·2	30°	81°	—	—	—	—	cr. ad. hair [vertebra, etc.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad. little hair, interparietal b. atlas
69°·1	75°·1	35°·8	11°·9	23°·9	87°	—	—	—	—	cal. ad. small and very heavy
67°·5	72°·5	40°	11°	29°	83°·5	—	—	—	—	cal. ad. flat nasal bones, prenasal fossa on
—	—	—	—	—	—	92	98	33	—	br. cr. when br.? [face, diseased teeth
—	—	—	—	—	—	—	—	—	—	cal. – f. y. ad. wormian bs. like Q 383 but
64°·2	80°·2	35°·6	7°·3	28°·3	87°·5	—	—	—	—	cal. ad. [less marked
70°·3	76°·9	32°·8	5°·6	27°·2	82°·5	—	—	—	—	cal. ad. [edly convex and sloped; interpar. b.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad. nuchal portion of occipital mark-
74°·7	72°	33°·3	9°·5	23°·8	81°·5	—	—	—	—	cal. y. ad.
—	—	—	—	—	81°·5	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad. interpar. b.
—	—	—	—	—	—	—	—	—	—	dome. old
—	—	—	—	—	—	—	—	—	—	cal. – f. ad. parietal sutures closed
—	—	—	—	—	82°·45	—	—	—	—	cal. ad.
—	—	—	—	—	91°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	—	—	—	cal. ad. [other wormian bones
71°·3	72°·9	35°·8	8°·6	27°·2	81°·5	—	—	—	—	cal. juvenile circa 17 yrs. large interpar. and
65°	84°	31°	−4°·5	35°·5	79°·5	—	—	—	—	cal. ad. hair. pterion
72°·4	73°·1	34°·5	9°·9	24°·6	83°	—	—	—	—	cal. ad.
—	—	—	—	—	—	91·5	105·25	33	46	cr. y. ad.
—	—	—	—	—	78°	—	—	—	—	br. cal. pterion. wormian bs.
—	—	—	—	—	—	—	—	—	—	br. cr. adolesc. spheno-pariet. sut. closed
—	—	—	—	—	—	—	—	—	—	frag.
—	—	—	—	—	—	89	—	27·5	45·5	br. cr. ad.
63°·5	82°·1	34°·4	7°·9	26°·5	90°	—	—	—	—	br. cr. y. ad.
—	—	—	—	—	—	—	—	—	—	br. cal. ad.
66°·2	79°·7	34°·1	4°·3	29°·8	84°	—	—	—	—	cal. ad. pterion on both sides
—	—	—	—	—	—	—	—	—	—	br. cal. – f.
70°	74°·7	35°·3	10°·8	24°·5	85°·5	—	—	—	—	cal. – f. adolesc.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	—	—	—	dome. ad.

34 frags.—Q 364 frags.—Q 411[b] frags.

Series No.	Grave No.	Sex	C	Lengths F	L′	L	B	B′	H	OH	LB	Circumferences U	S	Q	GH	G′H	GB	J	N
286	Q 496	♂	1275?	174	—	178	140	84	130	111·75	93	499·5	365	292	—	58	89	—	40
287	Q 509	♀	1299	174	177	175·5	136·5	—	129	113	—	493	—	298	—	—	—	—	-
288	Q 511	♀	1268	175	178	177	127·5	89·25	127·5	110	93	491	363	288	—	—	—	—	-
289	Q 513	♂	—	181·5	187	185	138·1	90	138	121	100	510	385	315	—	—	—	—	-
290	Q 528	♀	—	175·5	—	175·5	136·7	—	130·2	—	—	—	—	—	—	—	—	—	-
291	Q 544	♂?	—	197	194	195	139·7	92·5	139·2	118	100·25	539	404	330	—	—	—	—	-
292	Q 547	♀	—	—	—	196	131	86	—	—	—	—	—	—	—	—	—	—	-
293	Q 549*a*	♂?	1320	185	186	186·7	136·5	85	137	113	103	510	371	299	—	66	101·5	112·5	50
294	Q 549*b*	♀	—	182	184	181	129·7	93·75	—	118	—	502	372	305	—	65	98	114?	44
295	Q 564	♂	—	184·1	—	190·3	134·5	99	130·2	112	108	515	370	311	—	—	—	—	-
296	Q 565	♂?	—	—	—	—	125·5	87·5	138·75	118 (*h*)	—	—	—	298	—	61	96	—	48
297	Q 567	♀	—	177	179	177·5	133·5	91·8	134·1	116?	91·5	491·5	372·5	312	—	—	—	—	-
298	Q 569 A	♀	—	185	—	182	135?	87	—	113 (*h*)	—	—	—	—	—	—	—	—	-
299	Q 583	♀	—	186·3	—	185	136·3	89·5	—	—	—	—	390	—	—	66·5	87·5	—	45
300	Q 590	♀	—	—	178	176	—	79	139	115	96	—	355	—	—	—	—	—	-
301	Q 593	♀?	—	—	—	182	—	88	140	116	101·75	—	373	—	—	—	—	—	-
302	Q 598	♂	—	191	—	190	141·2?	—	136	—	—	—	—	—	—	—	—	—	-
303*a*	Q 610	♀	—	169	170	168·3	128·5	85?	128	110	89	475	354·3	291	—	—	—	—	-
303*b*	Q 615	♀	—	—	—	—	—	86	—	—	—	—	—	—	—	71	93?	—	49
304	Q 624	♀	1291	172·5	172	173·1	130·5	85·5	130	113	89	486	362	297	—	64?	92·5	115	48
305	Q 626	?	—	—	—	—	—	93	—	105·5 (*h*)	—	—	—	—	—	—	—	—	-
306	Q 631	♀	1261	177	174·5	177	129·5	90·5	130	113	99·5	494·5	365	290?	—	68	—	—	50
307	Q 634	♀?	—	—	—	—	—	84	—	—	—	—	387?	—	—	—	—	—	-
308	Q 639	♀	1380	175	179·5	177	134	85	130	110	85·5	497·5	366·5	294	—	—	—	—	-
309	Q 653	?	—	—	192·5	—	—	91	—	123	101·5	528	391	313	—	66	102	130·75	49
310	Q 673	♂	1485	189	193	193	137·5	93	144	122·5	104	531	389	314	—	68·5	90	—	48
311	Q 702	♂?	1303	189·2	188	188·5	131	91·5	137	114	99	516	374	292	—	64·5	88	123	44
312	Q 703	?	—	—	—	188·9	131·5	—	128·8	—	—	—	—	—	—	—	—	—	-
313	Q 754	♂	—	188	192·5	192	135·3	88	138	118	103	515	382	300	—	—	—	—	-
314	Q 758	♂	1575	200	197	197·1	133	94·75	140·2	118	105	535	394	310	—	69·5	101	130	51
315	Q 766	♀?	—	183	179·5	181	138·5	85	138	119·5	—	510	379	306	—	—	—	—	-
316	Q 776	?	—	—	182	—	—	83	—	118	—	509	377	305	—	—	—	—	-
317	Q 790	♂	1291	188·9	182	181·5	132	88·5	136·5	110	100	502	361·5	295	—	—	—	—	-
318	Q 791	♀	1353	175	175·5	173·2	129·7	82·75	136·4	115	90·5	483	371 5	295	—	62·5	85	114·5	46
319	Q 797	♀	1225	177	176	175	125·5	88·5	126	110	89·5	488	365	292	—	65	91	117	46
320	Q 798	♀	—	180	176?	179	126·25	86	143	119 (*h*)	89·25	486	378	—	—	58?	83·5	—	39
321*a*	Q 807	♂?	—	—	—	185	131·5	99	—	—	—	—	—	—	—	—	—	—	-
321*b*	Q 1272	?	—	—	—	—	—	93·25	—	100	—	—	—	—	—	68	97·6	—	46
322*a*	Q H. T	♂	—	188·5	—	190	133·5?	—	134	—	—	—	—	—	—	—	—	—	-
322*b*	Q *nn*²	?	—	—	—	192?	141·5	—	—	—	—	529	369	—	—	—	—	—	-
323*a*	B 2	♂	—	182	—	186	130·5	—	139	—	—	—	—	—	—	—	—	—	-
323*b*	B 4	?	—	—	—	191	130·5	99	—	—	—	525?	—	—	—	—	—	—	-
324	B 5	♀?	1355	171	176	174	136·5	90·5	140	120	102	489	357	313	—	64·5	96·4	—	52
325	B 12*b*	?	—	—	187·5	190	—	87·5	143	121·5	105	518	383	308	—	—	99·5	—	48
326	B 15*b*	♂	—	—	—	183·5	—	—	141	102·5 (*h*)	—	—	—	—	—	—	—	—	-
327	B 15*c*	♀	—	175	—	175	140·6	94	137	116 (*h*)	—	494	—	—	—	60	90	—	44
328	B 16*a*	♂?	—	—	—	193	139	89·5	—	107 (*h*)	—	—	—	—	—	—	—	—	-
329	B 21	♀	1223	170·3	170	170	127·2	90	128·5	112	90	477	359	295	—	60	89	119?	46
330	B 23*a*	♀	1355	182	181	181·5	133	90·25	136	117·25	97	502	369·5	311	—	67·5	99·5	118	51
331*a*	B 24*b*	♂	1498	183·5	185	186	140·5	95·75	145	125	100·5	523	385	326	—	—	—	—	52
331*b*	B 24*c*	?	—	—	—	—	138	—	141	—	—	—	—	—	—	—	—	—	-
332	B 30	♂	—	178·5	181·5	179·5	—	88	129	113·5	97	—	367	—	—	64	95	—	45
333	B 31	♂?	—	177	183?	181	127·5	88	127	108·25	104	491	354?	290	—	—	—	—	-
334	B 36	♂?	1463	187	187	185·5	135	92·5	133	119	98·5	517	381	312	—	67·5	94	123·5	48
335	B 39	♀	1300?	177	179	177	133	84	129·5	113·5	98·5	—	362·5	298	—	61	87·5	—	45
336	B 47	♂	1395?	173·5	177	177	139	86	139	123	100	495·5	375·5	325	109·25	66?	87	120	52
337	B 50*c*	♀	—	181·5	—	182·5	133·3	88·5	128	—	—	—	—	—	—	71	99·5	—	53
338*a*	B 69	♂	—	—	—	186	129·5	94	146	120 (*h*)	—	—	365	—	—	—	—	—	-
338*b*	B 76	♀	—	—	—	181?	—	87	—	121 (*h*)	—	—	—	—	—	65	96·5	—	44
339	B 77	♀	1190	173	174	173·5	126	87	125·7	109	89	484	351·5	288	109	—	84	116	45

Miscellanea : Q 506 f

MEASUREMENTS OF NAQADA CRANIA—*continu*

Face								Palate		Indic					
GB	*J*	*NH*	*NB*	*O*$_1$ *L*	*O*$_1$ *R*	*O*$_2$ *L*	*O*$_2$ *R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/GB*
89	—	40	23	38·5	37·5	29·5	30	52	37·5	—	—	78·7	73·0	107·7	—
—	—	—	—	—	—	—	—	—	—	77·1	72·9	77·8	73·5	105·8	—
—	—	—	—	—	—	—	—	—	—	71·6	71·6	72·0	72·0	100·0	—
—	—	—	—	—	—	—	—	—	—	73·9	73·8	74·6	74·6	100·7	—
—	—	—	—	—	—	—	—	—	—	—	—	77·9	74·2	105·0	—
—	—	—	—	—	—	—	—	—	—	72·0	71·8	71·6	71·4	100·4	—
—	—	—	—	—	—	—	—	—	—	—	—	66·8	—	—	—
01·5	112·5	50·5	24	42·6	41·5	35	35·5	53	46	73·4	73·7	73·1	73·4	99·6	—
98	114?	44	24	41	41	31	31·5	54	35	70·5	—	71·7	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	70·7	68·4	103·3	—
96	—	48	23	41·5	40	31·5	30	47?	34	—	—	—	—	90·5	—
—	—	—	—	—	—	—	—	—	—	74·6	74·9	75·2	75·5	99·6	—
—	—	—	—	—	—	—	—	—	—	—	—	74·2	—	—	—
87·5	—	45·5	24	43	43	34·5	31·5	55·5	36·5	—	—	73·7	—	—	—
—	—	—	—	—	—	—	—	—	—	—	78·1	—	79·0	—	—
—	—	—	—	—	—	—	—	—	—	—	—	76·9	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	74·3	71·6	103·8	—
—	—	—	—	—	—	—	—	—	—	75·6	75·3	76·4	76·1	100·4	—
93?	—	49·5	25·5	—	—	—	34	53	45	—	—	—	—	—	—
92·5	115	48	25	44	44	33·75	33	—	45	75·9	75·6	75·4	75·1	100·4	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	50·5	23·5	41	—	32·5	—	53·75	38	74·2	74·5	73·2	73·4	99·6	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	74·7	72·4	75·7	73·4	103·1	—
02	130·75	49	29·5	44·5	45	33	33·5	52	41	—	—	—	—	—	—
90	—	48	23	44·5	—	32	—	—	—	71·2	74·6	71·2	74·6	95·5	—
88	123	44	26	43·5	44	30	31	—	—	69·7	72·9	69·5	72·7	95·6	—
—	—	—	—	—	—	—	—	—	—	—	—	69·6	68·2	102·1	—
—	—	—	—	—	—	—	—	—	—	70·3	71·7	70·5	71·9	98·0	—
01	130	51	26	44	44	33	32	59·5	37·5	67·5	71·2	67·5	71·1	94·9	—
—	—	—	—	—	—	—	—	—	—	77·2	76·9	76·5	76 2	100·4	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	72·5	75·0	72·7	75·2	96·7	—
85	114·5	46	22·75	43	42·5	34	33	50	33	73·9	77·7	74·9	78·8	95·1	—
91	117	46	24·5	39·5	39·5	32	31	61	44	71·3	71·6	71·7	72·0	99·6	—
83·5	—	39·5	22·5	38	37·5	31	29·5	46?	30?	71·7	81·3	70·5	79·9	88·3	—
—	—	—	—	—	—	—	—	—	—	—	—	71·1	—	—	—
97·6	—	46	23	39·5	39	30	29	60	37	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	70·3	70·5	99·6	—
—	—	—	—	—	—	—	—	—	—	—	—	73·7?	—	—	—

B GRAVES.

—	—	—	—	—	—	—	—	—	—	—	—	70·2	74·7	93·9	—
—	—	—	—	—	—	—	—	—	—	—	—	68·3	—	—	—
96·4	—	52	24	43·5	41	34	35·5	—	—	77·6	79·5	78·4	80·5	97·5	—
99·5	—	48·5	27·5	44	43	33·5	33	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	76·8	—	—
00	—	44	20	39	39·5	31	30	—	—	—	—	80·3	78·3	102·6	—
—	—	—	—	—	—	—	—	—	—	—	—	72·0	—	—	—
89	119?	46	22	36	38	31	32	46·5	34	74·8	75·6	74·8	75·6	99·0	—
99·5	118	51	26	42	42	32·5	33	53?	39	73·5	75·1	73·3	74·9	97·8	—
—	—	52	29	43·75	—	31·5	—	45?	36?	76·0	78·4	75·5	78·0	96·9	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	97·9	—
95	—	45	21	41	39	30·75	29	54	40	—	71·1	—	71·9	—	—
—	—	—	—	—	—	—	—	—	—	69·7	69·4	70·4	70·2	100·4	—
94	123·5	48·5	23	42	42	29	29	53·6	35	72·2	71·1	72·8	71·7	101·5	—
87·5	—	45	26	41	43·5	31·5	31·5	52	39·5	74·3	72·3	75·1	73·2	102·7	—
87	120	52·25	25	40	41	33·5	32	50?	42	78·5	78·5	78·5	78·5	100·0	125·6
99·5	—	53	25	44·5	43	31·5	33	57	41	—	—	73·0	70·1	104·1	—
—	—	—	—	—	—	—	—	—	—	—	—	69·6	78·5	88·7	—
96·5	—	44	22	—	38	34	34	51	40	—	—	—	—	—	—
84	116	45	24	39·5	40	32·5	31·5	—	—	72·4	72·2	72·6	72·4	100·2	129·8

llanea: Q 506 frags.—Q 512 frags.—Q 686^c frags.—Q*nn*^{1} frags.—B 10 frags.—B 19 ♂ frontal bone + frags. *B'* =

SUREMENTS OF NAQADA CRANIA—*continued.*

		Palate		Indices											Angles					
O_2 / R		G_1	G_2	B/L'	H/L'	B/L	H/L	B/H	GH/GB	$G'H/GB$	NB/NH	O_2/O_1 L	O_2/O_1 R	G_2/G_1	GL	$N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$
5	30	52	37·5	—	—	78·7	73·0	107·7	—	65·2	57·5	76·6	80·0	72·1	—	—	—	—	—	—	—
	—	—	—	77·1	72·9	77·8	73·5	105·8	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	71·6	71·6	72·0	72·0	100·0	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	73·9	73·8	74·6	74·6	100·7	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	77·9	74·2	105·0	—	—	—	—	—	—	94	—	—	—	—	—	—
	—	—	—	72·0	71·8	71·6	71·4	100·4	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	66·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	35·5	53	46	73·4	73·7	73·1	73·4	99·6	—	65	47·5	82·2	85·5	86·8	—	—	—	—	—	—	86°
	31·5	54	35	70·5	—	71·7	—	—	—	66·4	54·5	75·6	76·8	64·8	—	—	—	—	—	—	—
	—	—	—	—	—	70·7	68·4	103·3	—	—	—	—	—	—	—	—	—	—	—	—	—
5	30	47?	34	—	—	—	—	90·5	—	63·5	47·9	75·9	75·0	72·3	—	—	—	—	—	—	—
	—	—	—	74·6	74·9	75·2	75·5	99·6	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	74·2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	31·5	55·5	36·5	—	—	73·7	—	—	—	76·0	52·7	80·2	73·3	65·8	—	—	—	—	—	—	—
	—	—	—	—	78·1	—	79·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	76·9	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	74·3	71·6	103·8	—	—	—	—	—	—	90·25	—	—	—	—	—	87°
	—	—	—	75·6	75·3	76·4	76·1	100·4	—	—	—	—	—	—	—	—	—	—	—	—	—
	34	53	45	—	—	—	—	—	—	76·4	51·5	—	—	84·9	—	—	—	—	—	—	—
75	33	—	45	75·9	75·6	75·4	75·1	100·4	—	69·2	52·1	76·7	75·0	—	85·5	68°	74°·6	37°·4	11°·4	26°	86°
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	53·75	38	74·2	74·5	73·2	73·4	99·6	—	—	46·5	79·3	—	70·7	93·5	72°	70°·2	37°·8	13°·5	24°·75	83°·2
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	74·7	72·4	75·7	73·4	103·1	—	—	—	—	—	—	—	—	—	—	—	—	—
	33·5	52	41	—	—	—	—	—	—	64·7	60·2	74·2	74·4	78·8	—	—	—	—	—	—	—
	—	—	—	71·2	74·6	71·2	74·6	95·5	—	76·1	47·9	71·9	—	—	94·5	63°·2	83°	33°·8	2°·5	31°·3	85°·5
	31	—	—	69·7	72·9	69·5	72·7	95·6	—	73·3	59·1	69·0	70·5	—	94·25	69°	78°·2	32°·8	8°·8	24°	87°
	—	—	—	—	—	69·6	68·2	102·1	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	70·3	71·7	70·5	71·9	98·0	—	—	—	—	—	—	—	—	—	—	—	—	—
	32	59·5	37·5	67·5	71·2	67·5	71·1	94·9	—	68·8	51·0	75·0	72·7	63·0	99	67°·2	77°·6	35°·2	7°·4	27°·8	85°
	—	—	—	77·2	76·9	76·5	76 2	100·4	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	72·5	75·0	72·7	75·2	96·7	—	—	—	—	—	—	—	—	—	—	—	—	—
	33	50	33	73·9	77·7	74·9	78·8	95·1	—	73·5	49·5	79·1	77·6	66·0	87·5	69°	75°	36°	9°·75	26°·25	84°·7
	31	61	44	71·3	71·6	71·7	72·0	99·6	—	71·4	53·3	81·0	78·5	72·1	91	73°·6	70°·3	36°·1	12°·2	23°·9	82°·5
	29·5	46?	30?	71·7	81·3	70·5	79·9	88·3	—	69·4	57·0	81·6	78·7	65·2	86·75	—	—	—	—	—	—
	—	—	—	—	—	71·1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	29	60	37	—	—	—	—	—	—	69·7	50·0	75·9	74·4	61·7	—	—	—	—	—	—	—
	—	—	—	—	—	70·3	70·5	99·6	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	73·7?	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

GRAVES.

	—	—	—	—	—	70·2	74·7	93·9	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	68·3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	35·5	—	—	77·6	79·5	78·4	80·5	97·5	—	66·9	46·2	78·2	86·6	—	90·75	62°	83°·3	34°·7	3°·2	31°·5	86°·5
5	33	—	—	—	—	—	—	—	—	—	56·7	76·1	76·7	—	98	—	—	—	—	—	—
	—	—	—	—	—	—	76·8	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	30	—	—	—	—	80·3	78·3	102·6	—	66·7	45·5	79·5	75·9	—	—	—	—	—	—	—	—
	—	—	—	—	—	72·0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	32	46·5	34	74·8	75·6	74·8	75·6	99·0	—	68·5	47·8	86·1	84·2	73·1	83·25	—	—	—	—	—	84°·5
5	33	53?	39	73·5	75·1	73·3	74·9	97·8	—	67·8	51·0	77·4	78·6	73·6	91	66°·2	76°·8	37°	9°·2	27°·8	86°
5	—	45?	36?	76·0	78·4	75·5	78·0	96·9	—	—	55·8	76·4	—	80·1	96	68°·6	77°	34°·4	8°	26°·4	85°
	—	—	—	—	—	—	—	97·9	—	—	—	—	—	—	—	—	—	—	—	—	—
75	29	54	40	—	71·1	—	71·9	—	—	67·4	46·7	75·0	74·4	74·1	90·5	66°·1	79°	34°·9	5°·25	29°·65	84°·2
	—	—	—	69·7	69·4	70·4	70·2	100·4	—	—	—	—	—	—	—	—	—	—	—	—	—
	29	53·6	35	72·2	71·1	72·8	71·7	101·5	—	71·8	47·4	69·0	69·0	65·3	95	69°·2	75°·7	35°·1	10°·8	24°·3	86°·5
5	31·5	52	39·5	74·3	72·3	75·1	73·2	102·7	—	69·7	57·8	76·8	72·4	76·0	92·5	67°·6	79°·8	32°·6	8°·2	24°·4	88°
5	32	50?	42	78·5	78·5	78·5	78·5	100·0	125·6	75·9	47·8	83·8	78·0	84·0	91	64°	81°	35°	7°·75	27°·25	88°·7
5	33	57	41	—	—	73·0	70 1	104·1	—	71·4	47·2	70·8	76·7	—	—	—	—	—	—	—	—
	—	—	—	—	—	69·6	78·5	88·7	—	—	—	—	—	—	—	—	—	—	—	—	—
	34	51	40	—	—	—	—	—	—	67·4	50·0	—	89·5	78·4	—	—	—	—	—	—	—
5	31·5	—	—	72·4	72·2	72·6	72 4	100·2	129·8	—	53·3	82·3	78·8	—	85	68°	76°	36°	8°	28°	84°

frags.—Qnn^1 frags.—B 10 frags.—B 19 ♂ frontal bone + frags. $B' = 92$.—B 62^a frags.—B 62^b frags. $B' = 93·5$.—B 65 frag.

TABLE VI.

θ_2	θ_1	$P\angle$	Mandible W_1	W_2	h_1	f	Remarks
—	—	—	—	—	—	—	cal. ad. very dendritic sutures
—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	cal. – f. torus occipitalis
—	—	—	—	—	—	—	cal. – f. ad.
—	—	—	—	—	—	—	br. cal. – f. ad.
—	—	—	—	—	—	—	br. dome ad.
—	—	—	—	—	—	—	frags.
—	—	86°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	impf. cr. ad. [foram.
—	—	—	—	—	—	—	cal. – f. + frags. y. ad. interpar. b. supraorb.
—	—	—	—	—	—	—	br. cal. ad. pterion
—	—	—	—	—	—	—	cal. – f. interpar. bone
—	—	—	—	—	—	—	br. cr. y. ad. cervical verteb.
—	—	—	—	—	—	—	br. dome + f. ad.
—	—	—	—	—	—	—	br. cal.
—	—	—	—	—	—	—	br. cal. – f. ad.
—	—	87°	—	—	—	—	br. cal. – parts of f. ad.
—	—	—	—	—	—	—	cal. juvenile. ? diseased
—	—	—	—	—	—	—	f. + frags. ad.
°·4	26°	86°	—	—	—	—	cal. y. ad. pterion, small interpar. b.
—	—	—	—	—	—	—	frags.
°·5	24°·75	83°·25	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	br. dome
—	—	—	—	—	—	—	cal. – part of f. ad.
—	—	—	—	—	—	—	br. cal. and frags.
°·5	31°·3	85°·5	—	—	—	—	cal. old. much closed sutures
°·8	24°	87°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	br. cal. when br. ?
—	—	—	—	—	—	—	cal. – f. + frags. ad.
°·4	27°·8	85°	—	—	—	—	cal. ad.
—	—	—	—	—	—	—	br. dome ad.
—	—	—	—	—	—	—	br. cal. – f. when br. ?
—	—	—	—	—	—	—	br. cal. – f. ad.
°·75	26°·25	84°·75	—	—	—	—	cal. y. ad. supraorb. foram. obelion depressed
°·2	23°·9	82°·5	—	—	—	—	cal. adolesc. pterion
—	—	—	—	—	—	—	br. cal. child
—	—	—	—	—	—	—	dome. ad. frags. of other crania
—	—	—	—	—	—	—	frags. + f. ad.
—	—	—	—	—	—	—	frags.
—	—	—	—	—	—	—	dome ad.
—	—	—	—	—	—	—	br. when br.?
—	—	—	—	—	—	—	frags. of cal. ad. wormian b.
°·2	31°·5	86°·5	—	—	—	—	cal. old
—	—	—	—	—	—	—	cal. f. br. old. small interpar. b.
—	—	—	—	—	—	—	dome + br. frontal
—	—	—	—	—	—	—	cal. – f. adolesc.
—	—	—	—	—	—	—	cal. – f. ad. interpar. b.
—	—	84°·5	—	—	—	—	cal. adolesc.
°·2	27°·8	86°	—	—	—	—	cal. ad.
°	26°·4	85°	—	—	—	—	cal. ad. wormian b. in sagit. sut.
—	—	—	—	—	—	—	frag.
°·25	29°·65	84°·25	—	—	—	—	br. cal. ad. interpar. b.
—	—	—	91 ?	119 ?	33	44	cal. – f. + m. ad. suts. largely closed
°·8	24°·3	86°·5	—	—	—	—	cal. ad.
°·2	24°·4	88°	—	—	—	—	cal. ad.
°·75	27°·25	88°·75	90·5	—	29?	43	cr. ad. supraorb. foram.
—	—	—	—	—	—	—	f. + m. + frags. ad. supraorb. foram.
—	—	—	—	—	—	—	br. dome. ad. sagit. sut. closed.
—	—	—	—	—	—	—	f. + frags. y. ad. supraorb. foram.
°	28°	84°	88·5	109	31	42	cr. ad.

Series No.	Grave No.	Sex	C	Lengths								Circumferences			Fac				
				F	L′	L	B	B′	H	OH	LB	U	S	Q	GH	G′H	GB	J	NH
390	R 1	♀	1090	163·5	164?	164	129	84	121·5	108·5	88	464?	328?	290?	—	56·5	84	111	41
391	R 2	♂?	1205	163·8	165	165	137·5	85	121	112	88	478	345	300	—	59·25	85	124	48·5
392	R 3	♀	1355	178	178·5	179	134	90	130	115	95	501·5	366	306	—	58·5?	85	119	49
393	R 4	♂?	1373	182	181·5	183	135·5	96·5	135·7	111	106	540·5	366	296	—	71·5	96	124	51·5
394	R 5	♂	1458	183	185·5	185	139	93	137	113	97·75	515·5	374	298	—	62	88	128	48·5
395	R 6	♂	1444	181	182·5	185	140	91	135·8	113	99	508	373·5	304	—	67	93	126	45
396	R 7	♀	1284	172·5	175·5?	174	136	90	124	110	94	490?	353·5?	294	—	66	95	122	49
397	R 8	♀?	1295	183	188?	186	128	90·5	123	110?	96·5	534?	370?	288?	—	68	97	126	50
398	I MAST.	?	—	184	—	188	136·7	—	131	—	—	—	—	—	—	—	—	—	—
399	U 6?	♂	—	—	—	184	130	—	141	120	—	—	—	—	—	—	—	—	—
400	G	♀	1215	171	170·5	171	136	91	126	110·5	92·5	485	355	298	103?	63?	92	118	46
401	G 6	♀	1260	175	175	175	136	85	128	113	97·75	493	365	297	—	—	—	—	—
402	*nn* (vii)	?	—	—	180	181	—	89	130	108·5	98	—	363	—	—	—	—	—	—
403	*nn* (viii)	?	—	—	—	—	—	—	—	115?	—	—	—	315?	—	—	—	—	—
404	*nn* (iii)	♀	—	—	—	177	—	90	132·5	116 (*h*)	93	—	365	—	—	65	87	—	44
405	*nn* (i)	♀	—	—	—	168	124	—	—	98 (*h*)	—	—	—	—	—	—	—	—	—
406	*nn* (ii)	♀	—	179·2	—	180	130?	—	124	95 (*h*)	95	—	359	—	—	—	—	—	—
407	*nn* (ix)	♂	—	—	—	—	—	94	—	112·5(*h*)	104·75	516	376	—	—	75	—	—	49
408	*nn* (v)	♂	1315	—	—	184	139	87·5	140	118·75(*h*)	95·5	—	361	—	—	60	92·5	—	46
409	*nn* (iv)	♂	—	—	183·5	183·5	—	90	137	113·5	94	—	366	—	—	71	96	120	51
410	? (i)	♂	—	—	—	182	—	88	137	112 (*h*)	—	—	376	—	—	—	—	—	—
411*a*	? (ii)	♂?	—	—	176·5	174	—	90·75	143·5	112·5	94	492?	369·5	297?	—	72	94	117?	53
411*b*	S_2	?	—	—	—	—	—	92	—	—	—	—	—	—	—	54	80	—	41

MANDIBLES

Series No.	Grave No.	Sex	W_1	W_2	h_1	f
412	81	♀	—	—	27·5	49
413	108*c*	?	—	—	31·5	—
414	113*c*	?	—	—	27	42
415	116	?	91·5	—	30·75	47·5
416	131	?	97	116	39	47
417	252	?	—	—	31?	—
418	269	?	—	—	36	—
419	269 *bis*	?	—	—	24·5?	—
420	273	?	—	—	31·5	45·5
421	279	?	—	—	29	46
422	343	♂	—	—	33	46
423	380	?	—	—	30	—
424	382	♂	—	—	34	—
425	408	?	88	115·25	29	42
426	408 *bis*	?	—	—	27	—
427	528	?	82	—	27	45
428	577	?	90	118·5	33	44
429	590	?	93	109	33	43
430	594*b*	♂	—	—	31	—
431	674	?	—	—	32	—
432	685	?	91	—	34	47
433	696	♀	87	103·5	34·5	46
434	711	♀	97?	—	33	48
435	716	♀	—	—	30	44
43[illegible]	728	♀	—	—	31	—

MEASUREMENTS OF NAQADA CRANIA—*continued.*

R GRAVES, UNNUMBERED BOXES, etc.

FACE								PALATE		INDI					
				O_1		O_2									
B	*J*	*NH*	*NB*	*L*	*R*	*L*	*R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/GL*
4	111	41	21	41	39	31	30	45	36	78·7	74·1	78·7	74·1	106·2	—
5	124	48·5	24	41	40	32·5	32·5	48	40	83·3	73·3	83·3	73·3	113·6	—
5	119	49	22	44	43·5	34	34	43?	—	75·1	72·8	74·9	72·6	103·8	—
6	124	51·5	28	41	43	36·5	36·5	57·5?	39	74·7	74·8	74·0	74·2	99·9	—
8	128	48·5	27	44·75	44·75	33	31·5	54	42	74·9	73·9	75·1	74·1	101·5	—
3	126	45	22·5	40	40	33	31	55	44	76·7	74·4	75·7	73·4	103·1	—
5	122	49	23·75	41·5	40	35	34·75	60·5	38·5	77·5	70·7	78·2	71·3	109·7	—
7	126	50	24·5	42·5	43	35	34·25	57	42	68·1	65·4	68·8	66·1	104·1	—
—	—	—	—	—	—	—	—	—	—	—	—	72·7	69·7	104·4	—
—	—	—	—	—	—	—	—	—	—	—	—	70·8	76·6	92·2	—
2	118	46	24	37	39	33·5	33	48?	43?	79·8	73·9	79·5	73·7	107·9	112·0?
—	—	—	—	—	—	—	—	—	—	77·7	73·1	77·7	73·1	106·3	—
—	—	—	—	—	—	—	—	—	—	—	72·2	—	71·8	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	—	44·5	23	40	40	34	33	51	35	—	—	—	75·4	—	—
—	—	—	—	—	—	—	—	—	—	—	—	73·8	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	72·2	68·9	—	—
—	—	49·25	—	42	—	32·5	—	—	—	—	—	—	—	—	—
2·5	—	46	24	39·5	40	34	34·75	52·5	43	—	—	75·5	76·1	99·3	—
6	120	51	27·5	44	44	33·5	34	56	36	—	74·7	—	74·7	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	75·3	—	—
4	117?	53	26?	—	—	35·5	36	50·5?	30	—	81·3	—	82·5	—	—
0	—	41	21	37·5	35·5	32	30	48·5	32	—	—	—	—	—	—

Miscellanea: *nn* (vi) frags. of two skulls.

MANDIBLES WITHOUT CRANIA, SEXED IN A FEW CASES FROM LONG

Series No.	Grave No.	Sex	W_1	W_2	h_1	f
437	731	♀	—	—	34·5	—
438	736	?	105?	—	33·5	50
439	739	?	—	—	25	—
440	740	♀	75	—	29?	45
441	803	?	—	—	30	—
442	873	♀	—	—	28	—
443	879*b*	?	—	—	32?	—
444	880	♂	—	—	34	—
445	1032	?	—	—	32	—
446	1037*c*	?	90	—	31	46
447	1201	?	—	—	30	—
448	1251	?	96·75	109·5	33	48
449	1304	?	78·75	—	29	45·5
450	1333	?	—	—	35	—
451	1504	♀	82	—	34	43
452	1558	?	81	105·25	28·5	42·5
453	1573	?	92	102	37	46
454	1577	?	80·5	97	27·75	41·5
455	1592 *bis*	?	—	—	35	43
456	1612	?	97	113	39·5	47·5
457	1614	?	91	113·5	32	41
458	1614 *bis*	?	—	—	27	—
459	1614 E	?	75	100	33	44
460	1621	?	79·5	—	28	42·5

Series No.	Grave No.	Sex	W_1
461	1653 *bis*	?	85
462	1654 E	?	86
463	1654 W	?	74·5
464	1656	?	87·5
465	1669	?	95
466	1729	♂	87·7
467	1734	?	—
468	1739 high	?	79·5
469	1756	?	85
470	1789	?	88
471	1813	?	82
472	1858	?	75
473	1866	♂	94·5
474	1901	?	103
475	1909	?	90
476	1914	♀	88·5
477	B 34*b*	♀?	78·5
478	B 42	?	—
479	B 48	♂	97
480	B 80	?	—
481	B 94	♀	91·5
482	B 105*a*	?	—
483	B 106	♂	—
484	B 107	♀	—

MEASUREMENTS OF NAQADA CRANIA—*continued.*

R GRAVES, UNNUMBERED BOXES, etc.

Face								Palate		Indices									
GB	*J*	*NH*	*NB*	O_1 *L*	O_1 *R*	O_2 *L*	O_2 *R*	G_1	G_2	*B/L'*	*H/L'*	*B/L*	*H/L*	*B/H*	*GH/GB*	*G'H/GB*	*NB/NH*	O_2/O_1 *L*	O_2/O_1 *R*	G_2/G_1	*GL*
84	111	41	21	41	39	31	30	45	36	78·7	74·1	78·7	74·1	106·2	—	67·3	51·2	75·6	76·9	80·0	83
85	124	48·5	24	41	40	32·5	32·5	48	40	83·3	73·3	83·3	73·3	113·6	—	69·7	49·5	79·3	81·3	83·3	85
85	119	49	22	44	43·5	34	34	43?	—	75·1	72·8	74·9	72·6	103·8	—	68·8	44·9	77·3	78·2	—	88·5
96	124	51·5	28	41	43	36·5	36·5	57·5?	39	74·7	74·8	74·0	74·2	99·9	—	74·5	54·4	89·0	84·9	67·8	91
88	128	48·5	27	44·75	44·75	33	31·5	54	42	74·9	73·9	75·1	74·1	101·5	—	70·5	57·7	73·8	70·4	77·8	95
93	126	45	22·5	40	40	33	31	55	44	76·7	74·4	75·7	73·4	103·1	—	72·0	50·0	82·5	77·5	80·0	90
95	122	49	23·75	41·5	40	35	34·75	60·5	38·5	77·5	70·7	78·2	71·3	109·7	—	69·5	48·5	84·3	86·9	63·6	91·7
97	126	50	24·5	42·5	43	35	34·25	57	42	68·1	65·4	68·8	66·1	104·1	—	70·1	49·0	82·4	79·7	73·7	96
—	—	—	—	—	—	—	—	—	—	—	—	72·7	69·7	104·4	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	70·8	76·6	92·2	—	—	—	—	—	—	—
92	118	46	24	37	39	33·5	33	48?	43?	79·8	73·9	79·5	73·7	107·9	112·0?	68·5	52·2	90·5	84·6	89·6?	89·7
—	—	—	—	—	—	—	—	—	—	77·7	73·1	77·7	73·1	106·3	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	72·2	—	71·8	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
87	—	44·5	23	40	40	34	33	51	35	—	—	—	75·4	—	—	74·7	51·7	85·0	82·5	68·6	—
—	—	—	—	—	—	—	—	—	—	—	—	73·8	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—	—	72·2	68·9	—	—	—	—	—	—	—	—
—	—	49·25	—	42	—	32·5	—	—	—	—	—	—	—	—	—	—	—	77·4	—	—	—
92·5	—	46	24	39·5	40	34	34·75	52·5	43	—	—	75·5	76·1	99·3	—	64·9	52·2	86·1	86·6	81·9	96·5
96	120	51	27·5	44	44	33·5	34	56	36	—	74·7	—	74·7	—	—	74·0	53·9	76·1	77·3	64·3	—
—	—	—	—	—	—	—	—	—	—	—	—	—	75·3	—	—	—	—	—	—	—	—
94	117?	53	26?	—	—	35·5	36	50·5?	30	—	81·3	—	82·5	—	—	77·7	46·0	—	—	60·2	93
80	—	41	21	37·5	35·5	32	30	48·5	32	—	—	—	—	—	—	67·5	51·2	85·3	84·5	66·0	—

Miscellanea: *nn* (vi) frags. of two skulls.

MANDIBLES WITHOUT CRANIA, SEXED IN A FEW CASES FROM LONG BONES OF SKELETONS.

Series No.	Grave No.	Sex	W_1	W_2	h_1	*f*
437	731	♀	—	—	34·5	—
438	736	?	105?	—	33·5	50
439	739	?	—	—	25	—
440	740	♀	75	—	29?	45
441	803	?	—	—	30	—
442	873	♀	—	—	28	—
443	879*b*	?	—	—	32?	—
444	880	♂	—	—	34	—
445	1032	?	—	—	32	—
446	1037*c*	?	90	—	31	46
447	1201	?	—	—	30	—
448	1251	?	96·75	109·5	33	48
449	1304	?	78·75	—	29	45·5
450	1333	?	—	—	35	—
451	1504	♀	82	—	34	43
452	1558	?	81	105·25	28·5	42·5
453	1573	?	92	102	37	46
454	1577	?	80·5	97	27·75	41·5
455	1592 *bis*	?	—	—	35	43
456	1612	?	97	113	39·5	47·5
457	1614	?	91	113·5	32	41
458	1614 *bis*	?	—	—	27	—
459	1614 E	?	75	100	33	44
460	1621	?	79·5	—	28	42·5

Series No.	Grave No.	Sex	W_1	W_2	h_1	*f*
461	1653 *bis*	?	85	103·5	35	40
462	1654 E	?	86	—	40	42
463	1654 W	?	74·5	—	32	40
464	1656	?	87·5	114?	31·5	48
465	1669	?	95	—	39	43
466	1729	♂	87·75	101·75	33·5	—
467	1734	?	—	—	28	—
468	1739high	?	79·5	97	32·5	39
469	1756	?	85	105	32	52
470	1789	?	88	110·5	28	44
471	1813	?	82	113·5	31·25	46·5
472	1858	?	75	105	29·75	40·5
473	1866	♂	94·5	—	38·5	42
474	1901	?	103	—	31·5	43
475	1909	?	90	107·25	29·5	43
476	1914	♀	88·5	108	35·75	43
477	B 34*b*	♀?	78·5	—	27	31
478	B 42	?	—	—	27	—
479	B 48	♂	97	—	34·5	47
480	B 80	?	—	—	34	44
481	B 94	♀	91·5	—	31·5	43
482	B 105*a*	?	—	—	34	—
483	B 106	♂	—	—	36	43
484	B 107	♀	—	—	33	—

Series No.
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G_1	G_2/G_1	GL	Angles: $N\angle$	$A\angle$	$B\angle$	θ_2	θ_1	$P\angle$	Mandible: W_1	W_2	h_1	f	Remarks
9	90	83	67°·5	78°·4	34°·1	11°·6	22°·5	90°	—	—	—	—	cal. child. interpar. b.
3	83·3	85	69°	74°·7	36°·3	13°·8	22°·5	88°·5	—	—	—	—	cal. ad.
2	—	88·5	66°	78°·6	35°·4	13°·4	22°	92°	—	—	—	—	cal. ad.
9	67·8	91	—	—	—	—	—	89°·75	—	—	—	—	cal. ad.
4	77·8	95	65°·1	77°	37°·9	7°	30°·9	84°	—	—	—	—	cal. ad. temporal fossa rather small, lower temporal line very strongly marked; small prenasal fossa; constriction across parts of parietal bones; sutures in temporal fossa mostly closed
5	80·0	90	64°·1	81°	34°·9	3°·5	31°·8	84°·5	—	—	—	—	cal. ad.
9	63·6	91·75	69°·7	74°	36°·3	6°·5	29°·8	80°·5	—	—	—	—	cal. ad. molars gone
7	73·7	96	71°·3	72°·2	36°·5	13°·3	23°·2	85°·5	—	—	—	—	cal. ad. scalp
-	—	—	—	—	—	—	—	—	—	—	—	—	br. or lost cr.
-	—	—	—	—	—	—	—	—	96·5	109	35	44	cal. – f. + frags., long styloid processes
6	89·6?	89·75	—	—	—	—	—	81°	88	102	26·5	43	br. cr. ad.
-	—	—	—	—	—	—	—	—	—	—	—	—	cal. – f. ad. inclined occipital
-	—	—	—	—	—	—	—	—	—	—	—	—	cal. – f.
-	—	—	—	—	—	—	—	—	—	—	—	—	frags. dome
5	68·6	—	—	—	—	—	—	—	—	—	—	—	br. cal. ad.
-	—	—	—	—	—	—	—	—	—	—	—	—	br. dome. y. ad.
-	—	—	—	—	—	—	—	—	—	—	—	—	frags. ad. long hair
-	—	—	—	—	—	—	—	—	—	—	—	—	br. cal. ad.
6	81·9	96·5	—	—	—	—	—	89°	—	—	—	—	f. + frags. ad.
3	64·3	—	—	—	—	—	—	—	—	—	—	—	f. + frags. ad.
-	—	—	—	—	—	—	—	—	—	—	—	—	br. dome + frags. y. ad.
-	60·2	93	71°·3	69°·4	39°·3	13°·6	25°·7	83°	—	—	—	—	br. cal. much inclined occipital
5	66·0	—	—	—	—	—	—	—	—	—	—	—	f. + frags. child

ONS.

Series No.	Grave No.	Sex	W_1	W_2	h_1	f
485	B 108	♀	86	107	—	43
486	B 119c	♀	83·5	—	34	42
487	Q 336	?	85	109·75	37·5	40
488	Q 358(2)	?	94	100	32·5	47·5
489	R A	?	88	112·5	23·75	41·5
490	R B	?	106	106	34·75	50
491	R C	?	89	106	27·5	44
492	R D	?	96	120	33·25	41·5
493	R E	?	86	113	30	44
494	R V	?	80	100	26·5	45·5
495	T 4 A, D, E, F?	?	92	—	27	43
496	T 4 C *bis*	♂	—	—	40	—
497	T 10 A	♂	92·75	113	34	45·5
498	T 23 *bis*	?	—	—	30	—
499	T 29 *bis*	?	—	—	33·5	41
500	T 30	♂	105	115	34	47
501	T 57	♂	101·5	111·5	38·5	45
502	A	?	81·5	108·75	31	44
503	B	?	—	—	37	46
504	C	?	—	—	32	40·5
505	D	?	—	—	25	44
506	*nn*	?	86	117·35	—	45
507	*β*	?	—	—	28	48
508	*φ*	?	—	—	38	—

m. = mandible. br. = broken. frag. = fragment. A mere reference to a suture denotes that it is abnormal in character. Again *Pterion* denotes some abnormality of the sutures at or near the pterion; the irregularities here were so diverse that they could not be properly indicated without individual drawings. In the age appreciations, which are of course only approximate, *child* = less than 15 years, *adolesc.* 15 to 20, *y. ad.* 20 to 30, *ad.* 30 to 50, and *old* above 50.

Finally it may be noted that, besides the boxes included in the *Miscellanea*, which correspond to definite graves, there are in the collection (i) a number of boxes containing minute fragments of skull bones, in most cases of a considerable number of skulls mixed together; (ii) boxes containing skulls or odd bones of deer, goat, dog, etc.; and (iii) boxes containing mandibles of man: these latter are mostly broken or are fragments only; many of them do not belong to the skulls. Those that do belong to the skulls have such measurements as were possible given under the skull number, and a further series of jaw measurements is given in a separate table. The teeth in these jaws are, if anything, more fragile than the cranial bones. Mr Augustus Winterbottom, F.R.C.S., to whom we have shown specimens, finds in them no marked difference from modern teeth. In some cases they are remarkably ground down,—a result possibly due to eating either grain or grain ground in soft stone mills.

BIOMETRISCHE UNTERSUCHUNGEN ÜBER DIE SPIELARTEN VON HELIX NEMORALIS.

Von C. HENSGEN, Plettenberg, Westfalen.

I.—*Einleitung.*

Die hier mitgetheilten Untersuchungen über die Varietäten von *Helix nemoralis*, die Entwickelung der Zeichnung auf dem Gehäuse sowie die Vertheilungsverhältnisse der so entstehenden Spielarten betreffend, bildeten Vorarbeiten, welche früher von mir lediglich zur persönlichen Orientirung ausgeführt wurden, um eine Grundlage zu Züchtungsversuchen zu bilden, betreffend Constanz und Variabilität dieser Formen bei gegebenen natürlichen und künstlichen Lebensbedingungen.

Wenn ich diese Arbeiten hier veröffentliche, so nehme ich an, dass dieselben auch ein allgemeineres Interesse beanspruchen dürften, weil wir es hier mit einem Untersuchungsmaterial zu thun haben, wie es unsere einheimische Fauna für derartige Arbeiten kaum besser zu bieten vermöchte.

Ich habe in dieser Arbeit auch die combinatorische Bestimmung der Variationen mit berücksichtigt, da dieselben bei allen derartigen Untersuchungen anwendbar sind, sofern sich für die einzelnen Varietätenformen der Individuen gewisse Begrenzungsgebiete feststellen lassen, und sich so bei der Vergleichung der theoretischen Möglichkeiten mit den natürlichen Ergebnissen schon gewisse Schlussfolgerungen ergeben. Ganz besonders ladet das Material, welches die Stylommatophoren dem Forscher bieten zu Züchtungsversuchen ein. Die Organisation dieser Mollusken als Zwitter würde schon an und für sich in dieser Beziehung interessante Resultate versprechen, als in Bezug auf die Befruchtung und über die Entwickelung der Jungen, sowie deren Vertheilung und Eigenschaften, bezogen auf das Elternpaar, nur sehr wenig bekannt zu sein scheint*.

In Bezug auf den bei Eintritt der kälteren Jahreszeit sonst beginnenden Winterschlaf der Thiere kann ich mittheilen, dass dieser bei Züchtungsversuchen

* Vide: Sporleder, A., Fortges. Beobachtungen über die Wachsthumszeit einiger Schnecken, *Malakozoolog. Blätter*, Bd. VII. (1861). Bronn's *Kl. u. Ordn. d. Thierreiches*, Bd. III.

in genügend temperirten und feucht gehaltenen Räumen vollständig wegfällt. Ich hatte seiner Zeit (1879) auf Fürsprache von Prof. Oscar Schmidt von Prof. de Bary in Strasburg Erlaubniss erhalten eine Anzahl von mit Drahtgittern verschlossenen Kästen in den Gewächshäusern des alten botanischen Gartens aufstellen zu dürfen und habe daselbst verschiedene Arten der Stylommatophoren bei vollkommener Lebensthätigkeit überwintert. [Diese Untersuchungen betrafen damals Absonderung und Beeinflussung der Bildung der Schalen.]

II.—*Combinatorische Berechnungen.*

Für alle Untersuchungen, welche die Vergleichung bestimmter Eigenschaften von Individuen zum Zwecke haben, ist es von Wichtigkeit die Zahl aller durch die Variabilität dieser Eigenschaften *überhaupt möglich werdenden characteristischen Formen* kennen zu lernen, so fern dieselben innerhalb gewisser durch die organische Anlage bedingter Grenzen sich festlegen lassen. Man ist dann in der Lage die gesetzmässig möglichen Formen mit den in der Natur wirklich beobachteten in Vergleich ziehen zu können, woraus sich weiter bereits oft wichtige Resultate für die biologische Forschung ergeben können.

Für die Varietäten, welche bei den Mollusken in Folge Variation in der Zeichnung der Schalen und Gehäuse entstehen können, sind in Bezug auf die Lage jener Zeichnungen bestimmte feste Gebiete gegeben, in Abhängigkeit von der Lage und Vertheilung der Farbdrüsen im Mantel der Thiere, welche Drüsen ja die Ausscheidung des Farbstoffes an den nächstliegenden Stellen der Umhüllung bedingen. Bei den Streifenvarietäten der Heliceen, welche im Besonderen hier in Betracht kommen, handelt es sich daher bei der combinatorischen Berechnung um Combinationen ohne Wiederholung und ohne Inversionen. Es ist nun ferner bei der Feststellung möglicher Formen darauf Bedacht zu nehmen, dass in allen Fällen, bei denen durch Verbreiterung einzelner nebeneinander liegender Streifen eine Verschmelzung dieser zu einem gemeinschaftlichen Bande stattfindet (wodurch eine scheinbare Verminderung der absoluten Streifenzahl eintritt) dies sowohl in der combinatorischen Berechnung als auch bei der Classificirung der in der Natur beobachteten Funde zum Ausdruck gelangt. Ich bezeichne daher die durch die normalen Lagegebiete von Drüsen erzeugten farbigen Ausscheidungen als *Streifen*, die durch Zusammenfliessen solcher Streifen erzeugten Verbreiterungen als *Bänder*. Die Bezeichnung der Streifen selbst ist die übliche, ausgedrückt durch die Zahlenreihe 1, 2, 3... u. s. w. und dabei ausgehend von dem, dem Nabel am nächsten liegenden Streifen. Bei den Bändern sind die, die betheiligten Streifen anzeigenden Zahlen durch umfassende Klammern gekennzeichnet.

A. *Die combinatorisch möglichen Formen in den Variationen der Streifung, welche durch Verschwinden von* n *Streifen oder durch deren Zusammenfliessen zu Bändern entstehen können, als Formen von Combinationen ohne Wiederholung und ohne Inversionen.*

I. *Keine Streifen*

Summe $S=1$.

II. *Ein Streifen*

$$S=n.$$

III. *Zwei Streifen oder deren Band*

$$S=\frac{n(n-1)}{1.2}+(n-1)=\tfrac{1}{2}[n^2+n-2].$$

IV. *Drei Streifen und deren Bänder*

$$S=\frac{n(n-1)(n-2)}{1.2.3}+(n-2)+(n-2)(n-1)$$
$$=\tfrac{1}{6}[n^3+3n^2-10n].$$

V. *Vier Streifen und deren Bänder*

$$S=\frac{n(n-1)(n-2)(n-3)}{1.2.3.4}+(n-3)+(n-3)(n-2)$$
$$+\tfrac{1}{2}(n-3)(n-2)+(n-1)\frac{(n-2)(n-3)}{1.2}$$
$$=\tfrac{1}{24}[n^4+6n^3-25n^2-30n+72].$$

VI. *Fünf Streifen und deren Bänder*

$$S=\frac{n(n-1)(n-2)(n-3)(n-4)}{1.2.3.4.5}+(n-4)+(n-3)(n-4)$$
$$+(n-2)\frac{(n-3)(n-4)}{1.2}+(n-1)\frac{(n-2)(n-3)(n-4)}{1.2.3}+(n-3)(n-4)$$
$$+\tfrac{1}{2}(n-3)(n-4)$$
$$=\tfrac{1}{120}[n^5+10n^4-45n^3-190n^2-584n]$$

u. s. w. für 6, 7.....Streifen.

B. *Gesonderte Berechnung, getrennt nach den theoretisch möglichen Formen an* (1) *Streifen,* (2) *Bänderformen, sowie* (3) *Combinationen von Streifenformen mit Bänderformen für* n *gegebene Elemente.*

1. *Streifenformen*

$S=2^n$ (einschliesslich der Form $n=0$, der streifenlosen Form).

2. *Bänderformen:*

a. *Für ein Band*

$$S=\tfrac{1}{2}n(n-1).$$

b. *Für zwei Bänder:*

α. *Bei betheiligten* 4 *Streifen und Bändern von je* 2 *und* 2 *Streifen*

$$S=\tfrac{1}{2}(n-2)(n-3).$$

β. *Bei* 5 *Streifen und Bändern von je* 3 *u.* 2 *oder* 2 *u.* 3 *Streifen*

$$S=(n-3)(n-4).$$

γ. *Bei* 6 *Streifen und Bändern von je*

$$\left.\begin{matrix}2\ u.\ 4\\4\ u.\ 2\\3\ u.\ 3\end{matrix}\right\}\ \textit{Streifen}$$

$$S=\tfrac{3}{2}(n-4)(n-5).$$

δ. *Bei 7 Streifen mit Bändern von je*

$$\left.\begin{matrix}2 \text{ u. } 5\\5 \text{ u. } 2\\3 \text{ u. } 4\\4 \text{ u. } 3\end{matrix}\right\} \textit{Streifen}$$

$$S=2(n-5)(n-6),$$

und so weiter.....

c. *Für drei Bänder:*

c. I. α. *Bei je* 2, 2 *und* 2 *Streifen*

$$S=\tfrac{1}{2}[(n-4)(n-5)+(n-5)(n-6)+(n-6)(n-7)+\ldots+2.1].$$

c. I. β. *Bei je*

$$\left.\begin{matrix}2, 2 \text{ u. } 3\\2, 3 \text{ u. } 2\\3, 2 \text{ u. } 2\end{matrix}\right\} \textit{Streifen}$$

$$S=\tfrac{3}{2}[(n-5)(n-6)+(n-6)(n-7)+\ldots+2.1].$$

c. I. γ. *Bei Bändern von je*

$$\left.\begin{matrix}2, 2 \text{ u. } 4\\2, 4 \text{ u. } 2\\4, 2 \text{ u. } 2\end{matrix}\right\} \textit{Streifen}$$

$$S=\tfrac{3}{2}[(n-6)(n-7)+\ldots+2.1],$$

und so weiter.

c. I. δ. *Bei Bändern von je*

$$\left.\begin{matrix}2, 2 \text{ u. } (n-4)\\2, (n-4) \text{ u. } 2\\(n-4), 2 \text{ u. } 2\end{matrix}\right\} \textit{Streifen}$$

$$S=\tfrac{3}{2}[1.2].$$

Oder total:

$$S=\tfrac{1}{2}(n-4)(n-5)+\tfrac{4}{2}(n-5)(n-6)+\tfrac{7}{2}(n-6)(n-7)$$
$$+\tfrac{10}{2}(n-7)(n-8)+\ldots\ldots$$

c. II. *Bei je*

$$\left.\begin{matrix}2, 3 \text{ u. } 3\\3, 2 \text{ u. } 3\\3, 3 \text{ u. } 2\end{matrix}\right\} \textit{Streifen}$$

$$S=\tfrac{3}{2}[(n-6)(n-7)+(n-7)(n-8)+\ldots\ldots].$$

c. III. α. *Bei je*

$$\left.\begin{matrix}2, 3 \text{ u. } 4\\2, 4 \text{ u. } 3\\3, 2 \text{ u. } 4\\3, 4 \text{ u. } 2\\4, 3 \text{ u. } 2\\4, 2 \text{ u. } 3\end{matrix}\right\} \textit{Streifen}$$

$$S=\tfrac{1}{2}(3.2)[(n-7)(n-8)+(n-8)(n-9)+\ldots\ldots].$$

c. III. β. Bei je

2, 3 *u.* 5
2, 5 *u.* 3 } *Streifen*
u. s. w.

$$S=\tfrac{1}{2}(3.2)[(n-8)(n-9)+(n-9)(n-10)+\ldots\ldots]$$

u. s. weiter.

c. III. γ. Bei je

2, 3 *u.* 6
2, 6 *u.* 3 } *Streifen*
u. s. w.

$$S=\tfrac{1}{2}(3.2)[(n-9)(n-10)+\ldots\ldots].$$

Oder total:

$$(3.2)[(n-7)(n-8)+2(n-8)(n-9)+3(n-9)(n-10)+\ldots\ldots+\ldots\ldots].$$

c. IV. Bei je

2, 4 *u.* 4
4, 2 *u.* 4 } *Streifen*
4, 4 *u.* 2

$$S=\tfrac{3}{2}[(n-8)(n-9)+(n-9)(n-10)+\ldots\ldots].$$

c. V. Bei je

2, 4 *u.* 5
2, 5 *u.* 4 *u. s. w.*
2, 4 *u.* 6
2, 6 *u.* 4 *u. s. w.* } *Streifen*
2, 4 *u.* 7
2, 7 *u.* 4 *u. s. w.*

$$S=\tfrac{1}{2}(3.2)[(n-9)(n-10)+2(n-10)(n-11)+\ldots\ldots+\ldots\ldots]$$

u. s. weiter.

Für eine 4m. Anzahl, 5m. Anzahl u. s. w. von Bändern lassen sich so alle möglichen Combinationen von Bändern zusammenstellen.

III.—*Combinationen dieser Bänderformen mit Streifenformen.*

Hierfür ergiebt sich allgemein:

Sind $c_{p,q,r,s\ldots\ldots}$ die Anzahl Combinationen von *Bändern*, bestehend aufeinanderfolgend aus p, q, r, $s\ldots$ zusammengeschlossenen *Streifen*, so ist die Anzahl der Combinationen dieser Bänder mit 1, 2, 3 u. s. w. Streifen

$$S = C_{p,q,r,s\ldots\ldots} \times (2^{n-p-q-r-s\ldots\ldots}-1)$$

wobei $n=1$ resp. 2, 3, u. s. w. ist.

Die Grösse der Betheiligung der einzelnen Streifen bei der Bildung sämmtlicher combinatorisch möglichen Formen ist eine ziemlich gleiche für die hier in Betracht kommenden Untersuchungen*, wie sich aus der nachstehenden Zusammenstellung ergiebt. Wir werden später sehen, wie das Vorherrschen einzelner Streifen und

* $n=5$.

Varietäten bei den beobachteten Funden, dieses Verhältniss der Vertheilung recht wesentlich verändert (Tabelle D).

Vertheilung des Vorkommens der Streifen enthalten in den Combinationen.

Bezeichnung der Streifen. Streifen No.	Mit Streifen					Summe
	1	*2*	*3*	*4*	*5*	
1	1	5	13	20	16	55
2	1	2+4	8+8	16+8	16	63
3	1	1+2+3	7+6+4	16+8	16	64
4	1	1+1+1+2	6+6+4	16+8	16	63
5	1	1+1+1+2	5+4+4	12+8	16	55

IV.—*Die Sammlungen.*

Nach der Belagerung und Einnahme von Strasburg in 1870 war ein grosser Theil der zerstörten Angriffsfront des Nordens der Befestigung in Rücksicht auf die geplante Erweiterung derselben eine Reihe von Jahren liegen geblieben. Unter solchen Verhältnissen waren für die Entwickelung einer reichen Klein-Fauna Bedingungen geschaffen, wie sie sich kaum günstiger denken lassen, und so fand sich auch hier *Helix nemoralis* auf dem Mauerwerk der Befestigungen (alles noch nach dem alten Vauban'sche System aufgeführt) so wie dem sich anschliessenden hochwuchernden Strauchwerk in zahlreichen Exemplaren vor.

Wie weit hier in unmittelbarster Nähe des geräuschvollen Grossstadtlebens eine in sich abgeschlossene Wildniss entstanden war, bewiesen die an sonnigen Mittagen aus Mauerspalten und Schlupflöchern hervorgekrochenen Nattern* von oft beträchtlicher Grösse, die zusammengerollt auf dem Strauchwerk sich sonnten. Verwilderte Hauskatzen zogen in den Schusslöchern ihre Jungen auf und einmal traf ich an hellem Nachmittage sogar eine Katze (die doch sonst das nasse Element möglichst scheut) mitten im Wassergraben bis an den Kopf im Wasser still auf dem Schilfe liegend, um einem in der Nähe mit ihren Küken herumschwimmenden Wasserhuhn aufzulauern.

Diese kurzen Angaben mögen genügen um zu zeigen, in welchem stillen und abgeschlossenen Zustande die von mir abgesuchten Fundorte seinerzeit† sich befanden.

Wenn ich bei den vorliegenden Sammlungen der Begrenzung der Fundorte durch mehrfache Wasserläufe sowie künstliche nasse Gräben eine gewisse Bedeutung für die Funde beilege, so bin ich mir andererseits des bedingten Werthes solcher Absperrungen wohl bewusst, denn obwohl einerseits die primitive Ent-

§ Hauptsächlich *Tropidonotus natrix.*

† An diesen Stellen erheben sich jetzt der Kaiserpalast, die Bibliothek, die Gebäude der Kaiserstrasse sowie die neuen Universitätsbauten.

wickelung der Locomotion der Pulmonaten gegen eine weitgehende active Wanderung dieser Mollusken spricht, so sind andererseits doch vielfache Beobachtungen vorhanden, die auf eine bemerkenswerthe Ueberschreitung des eigentlichen Verbreitungsgebietes hinweisen, und kann ich die Mittheilungen von Kobelt* nur bestätigen. *Helix pomatia* z. B. fand ich in einer Anzahl Enclaven, die für das Kalkbedürfniss der Thiere besonders günstige Bedingungen boten, innerhalb eines Zeitraumes von 10 Jahren jedes Jahr regelmässig in gut entwickelten starkschaligen Exemplaren wieder, und zwar in den Thaleinschnitten von Lenne, Bigge und Veischede im Sauerlande, am Schloss zu Bilstein, auf Ruine Schnellenberg bei Attendorn, Ruine Schwarzenberg und Schloss Brüninghausen bei Plettenberg, Schlossberg zu Altena und Schloss zu Hohenlimburg, trotz des für *H. pomatia* verhältnissmässig hochgelegenen rauhen Gebietes†.

Immerhin wird man aber zugeben müssen, dass bei den so zahlreich (an den Fundorten I, II, IV u. V besonders recht übereinstimmend) beobachteten Individuen von *H. nemoralis*, hier für diese Art wenig Veranlassung gegeben war ihr von mehrfachen Wasserlinien begrenztes Gebiet durch active Wanderung in grösserer Zahl zu verlassen oder von aussen her einen grösseren Zuzug zu erhalten, so dass die vorgefundenen Vertheilungsverhältnisse der Varietäten auch auf eine gewisse natürliche Grundlage zurückgeführt werden können.

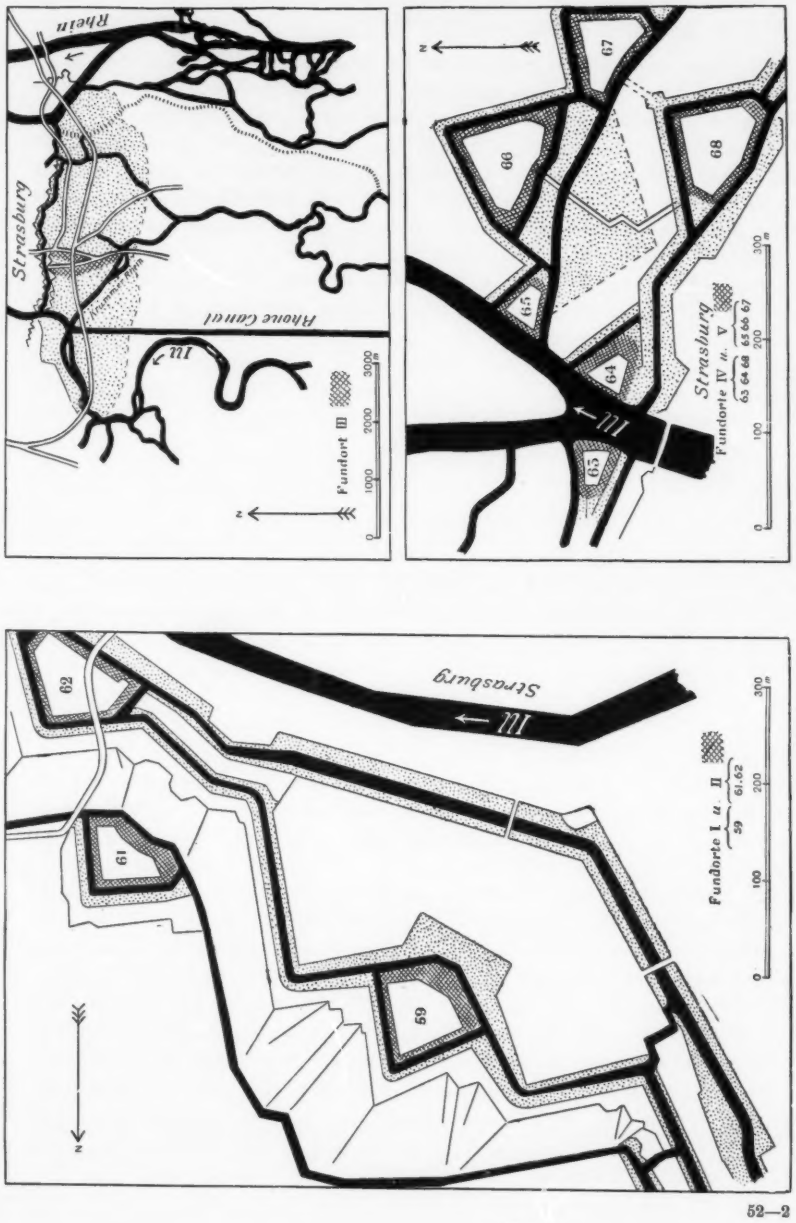
Dass übrigens schon geringe Aenderungen in den allgemeinen Lebensbedingungen auf die Variabilität, in Bezug auf die Entwickelung der Streifung, Einfluss ausüben können, ergiebt sich schon deutlich aus einer Vergleichung der Vertheilungsverhältnisse von den obenerwähnten vier Fundorten I, II, IV u. V mit den Funden der Sammlung III, worauf ich noch zurück kommen werde.

Die Sammlungen für jeden einzelnen Fundort fanden hintereinander an demselben Tage statt und zwar wurde dazu ein solcher ausgesucht, bei welchem auf ein zahlreiches Verlassen der Schlupfwinkel der Thiere zu rechnen war, also warme Witterung nach vorausgegangenem Regen bei zugleich hoher Dampftension der Luft. Letzteres ist sehr wichtig, da die Pulmonaten sehr empfindlich gegenüber dem Gehalte der Luft an Wasserdampf sind und bei scheinbar feuchter Witterung (nassem Boden) aber sehr trockner umgebender Luftströmung sich oft zurückgezogen halten, wie ich dies auch durch Versuche bei künstlich hergestellten verschiedenen Gehalten von Luft an Wasserdampf feststellen konnte.

Für die Bestimmungen der Art wurden von jeder Sammlung eine Anzahl Exemplare sowie alle zweifelhaften Funde näher untersucht, Form der Kiefer und

* Kobelt, *Studien zur Zoogeographie*, Wiesbaden 1897–98, pag. 29 u. folg. Siehe auch Müllenhof, *Die Ortsbewegung der Thiere.*

† Auf den primären Lagerstätten des Kalksteins bei Attendorn im Biggethale sowie zu Lethmate an der Lenne habe ich *H. pomatia* nicht angetroffen. Es scheinen hiernach der aus Aetzkalk hergestellte Mauerkalk und Weisskalk für die Thiere besonders günstig für die Assimilation zu sein, wofür auch anderweitige Beobachtungen sprechen. Dieses durchsuchte Gebiet hat eine Länge von über 80 Kilometern.



Inundationsgebiet = ▒ Wasser = ▬

Karte der Fundorten.

die Zähnung der Radula controllirt, sowie besonders die Form der Liebespfeile, soweit solche vorhanden waren, festgestellt*.

Auch wurde zur Aufgabe gemacht, an jedem Fundorte das bestimmte Gebiet auf alle möglichen zugänglichen Exemplare abzusuchen, und ferner neben ausgewachsenen Exemplaren auch alle jungen Thiere mit zu berücksichtigen. Für das Fundverhältniss zwischen ausgewachsenen und jungen Thieren ist allerdings ein persönlicher Fehler immer insofern vorhanden, als die jungen Thiere weniger leicht gefunden werden können, indessen zeigt doch auch hier die Vergleichung der Verhältnisse zwischen alten und jungen Thieren eine befriedigende Annäherung der Werthe. Eine Abweichung in den Verhältnissen alter und junger Thiere muss aber nothwendig noch aus dem andern Grunde eintreten (der mich ja veranlasste auf diesen Umstand bei Sammlungen Rücksicht zu nehmen), als nämlich Zeichnungen oft erst nahe dem Rande zu auftreten. Zur Beleuchtung dieser Thatsache sind in der Tabelle C diese unvollkommenen Spielarten und die Betheiligung der einzelnen Streifen dabei besonders zusammengestellt. Auf der Karte, Seite 475, sind die Fundorte mit besonderer Berücksichtigung der wasserführenden Begrenzungen wiedergegeben.

V.—*Zusammenstellungen und Folgerungen.*

Die Vergleichung der Werthe in den Rubriken der Tabelle A für die Streifenformen, beobachtet an den fünf Fundorten und nach dem Vorkommen von 1, 2... bis 5 Streifen zusammengestellt, sowie die hiernach auf den Figuren 1 bis 5 wiedergegebenen graphischen Darstellungen zeigen eine in der Hauptsache gleiche Zu- und Ab-nahme in den Curvenstücken, so dass die Schlussfolgerung wohl gestattet sein dürfte, dass auf Grundlage der Fundmengen sich hier schon Näherungswerthe an die wirkliche Vertheilung an diesen Fundorten berechnen lassen.

Ein wesentlicher Unterschied zwischen den Funden von I, II, IV u. V und den Funden von III zeigt sich (wie schon früher erwähnt wurde) insofern, als bei III die streifenlose Form bedeutend zurücktritt, und andererseits die vollkommenste Form 1.2.3.4.5 mit ihren Nebenspielarten eine beträchtliche Zunahme erfahren hat, wie dies in den späteren Curven Fig. 3, *a* u. *b* noch deutlicher zum Vorschein kommt. Dieses Resultat steht aber in vollkommenem Einklang mit der allgemeinen Beobachtung, dass Entwicklung von Farbe und Zeichnung im Thier- und Pflanzenreiche in einem gewissen Zusammenhang mit der Stärke und Dauer der Belichtung stehen und das gebotene Maximum an Licht durchaus nicht fördernd für die Entwicklung farbiger Spielarten ist. Für den Fundort III ergaben sich aber bei der daselbst vorhandenen günstigen Belaubung auch günstigere Bedingung zu einer kräftigerer Entwicklung von Farbenvarietäten, während umgekehrt die stets dem ganzen Tageslichte angesetzten Fundorte von I, II, IV u. V eine

* Siehe hierüber auch: Schmidt, A., *Der Geschlechtsapparat der Stylommatophoren* (Berlin 1885), sowie von demselben: Artenunterschied von *H. nemoralis* und *H. hortensis* unter Berücksichtigung der Liebespfeile, *Zeitschr. f. Malakozoologie* VI. S. 49 (1849).

TABELLE A, I.

Fundorte		Zahl der Streifen						Summe	
		0	*1*	*2*	*3*	*4*	*5*		
I	*a*	339	14	5	86	5	39	488	1297
	j	569	25	35	141	9	30	809	
II	*a*	138	37	3	100	1	17	296	545
	j	133	28	14	53	6	15	249	
III	*a*	127	54	2	58	7	211	459	930
	j	171	39	1	82	6	172	471	
IV	*a*	228	100	35	263	7	31	664	1505
	j	382	150	81	192	3	33	841	
V	*a*	136	72	19	120	4	20	371	864
	j	213	74	39	146	3	18	493	
Summe	*a*	968	277	64	627	24	318	2278	
	j	1468	316	170	614	27	268	2863	
Total		2436	593	234	1241	51	586	5141	

a = ausgewachsene, *j* = junge Thiere.

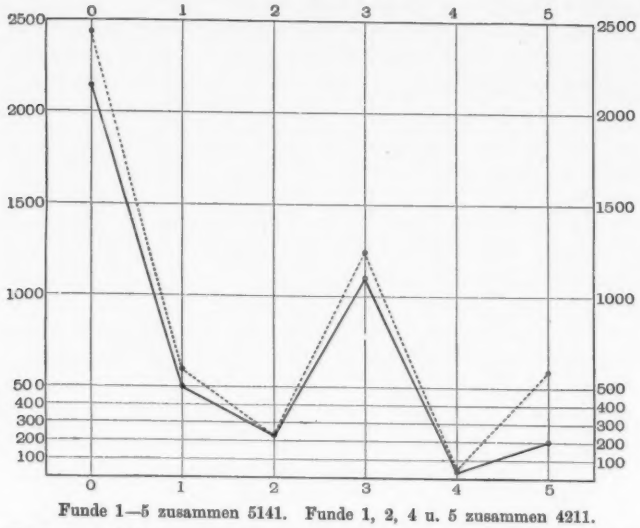
TABELLE A, II.

Vergleichswerthe der Fundmenge für (*a*) 100 *ausgewachsene und* (*j*) 100 *junge Thiere von jedem Fundort berechnet.*

Fundorte		Zahl der Streifen					
		0	*1*	*2*	*3*	*4*	*5*
I	*a*	69·47	2·87	1·02	17·62	1·02	8·00
	j	70·33	3·09	4·33	17·43	1·11	3·71
II	*a*	46·62	12·50	1·01	33·78	0·34	5·74
	j	53·41	11·24	5·62	21·29	2·42	6·02
III	*a*	27·67	11·76	0·44	12·64	1·53	45·97
	j	36·31	8·28	0·21	17·41	1·27	36·52
IV	*a*	34·34	15·06	5·27	39·61	1·05	4·67
	j	45·42	17·84	9·63	22·83	0·36	3·92
V	*a*	36·66	19·41	5·12	32·34	1·08	5·39
	j	43·20	15·01	7·91	29·61	0·62	3·65

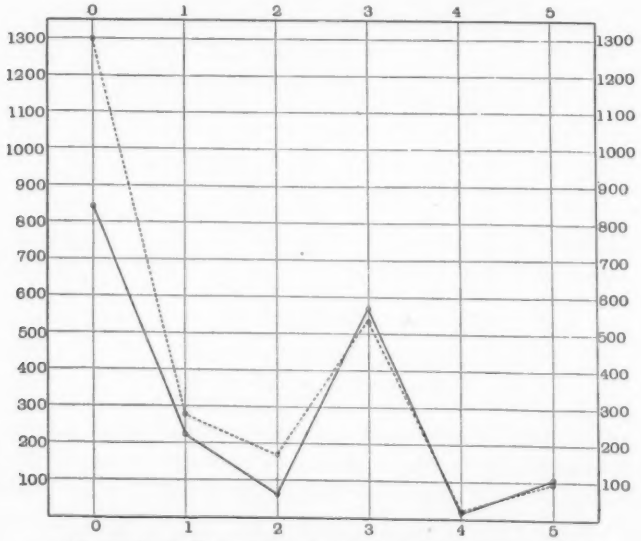
a = ausgewachsene, *j* = junge Thiere.

Zunahme an streifenlosen Exemplaren aufwiesen. Es ist daher auch auf diesen Umstand insofern mit Rücksicht genommen, als die Vergleichung und Zusammenfassung der Ergebnisse der letzteren Fundorte, der unter den gleichen Lebensbedingungen sich entwickelnden Thiere, auch in den gesonderten Curven auf Fig. 1 u. 2 (sowie später noch Fig. 3 *a* u. *b*) zum Ausdruck gelangt ist und, wie die Zahlen zeigen, auch nicht unberücksichtigt bleiben darf.



Funde 1—5 zusammen 5141. Funde 1, 2, 4 u. 5 zusammen 4211.

Fig. 1. Funde 1—5 addirt (punktirte Linie); Funde 1, 2, 4 u. 5 addirt (continuirliche Linie).



Ausgewachsene Thiere 1819. Junge Thiere 2392. Summe 4211.

Fig. 2. Funde 1, 2, 4 u. 5, die gleichen Lebensbedingungen entsprechen.

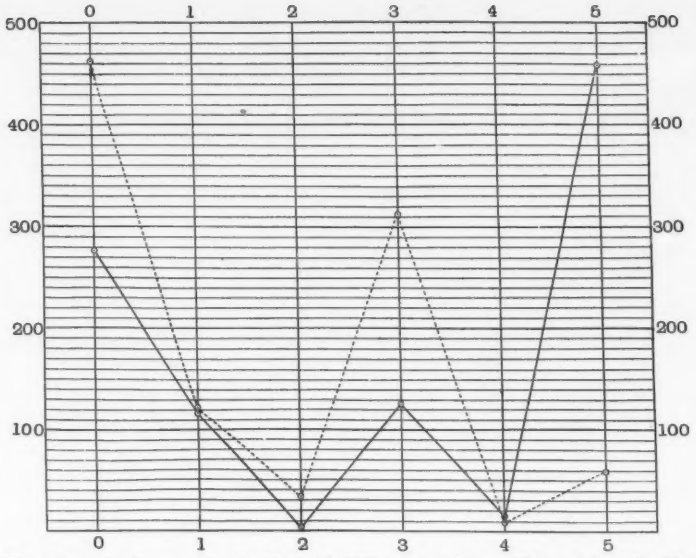


FIG. 3. Berechnetes Vorkommen der Streifen bei je 1000 ausgewachsenen Thieren (*a*) von den Fundorten 1, 2, 4 und 5 (punktirte Linie) und (*b*) vom Fundort 3 (continuirliche Linie).

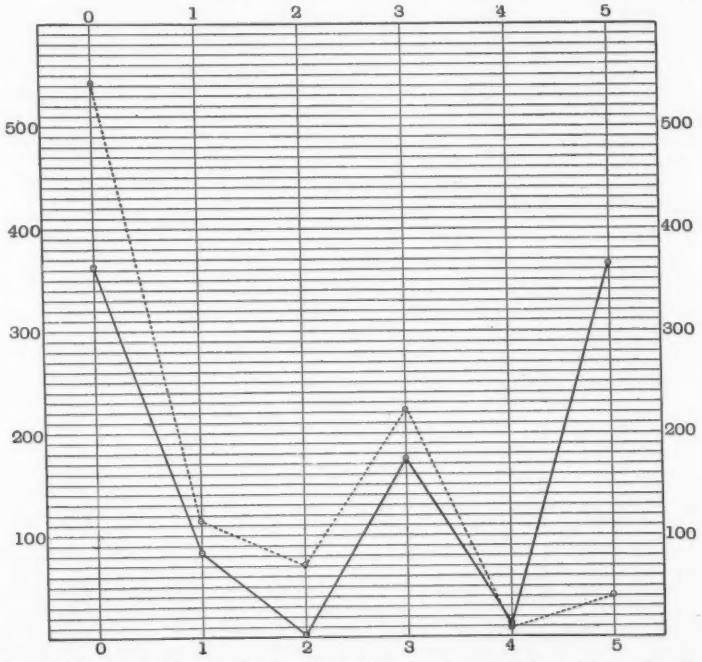


FIG. 4. Berechnetes Vorkommen der Streifen bei je 1000 jungen Thieren (*a*) von den Fundorten 1, 2, 4 und 5 (punktirte Linie) und (*b*) vom Fundort 3 (continuirliche Linie).

TABELLE B.

Wiedergabe sämmtlicher möglicher und beobachteter Varietäten aller fünf Fundorte.

(*a*=ausgewachsene, *j*=junge Thiere.)

	Lage der Streifen resp. Bänder	Fundorte										Summe			
		I		II		III		IV		V					
		a	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a+j*	
	0	339	569	138	133	127	171	228	382	136	213	968	1468	2436	
Gebiet von einem Streifen	*1*	—	—	—	—	—	—	—	—	—	—	—	—	—	Ein Streifen 593
	. *2* . . .	—	2	—	—	—	—	—	—	—	—	—	2	2	
	. . *3* . .	14	23	37	28	54	39	100	150	72	74	277	314	591	
	. . . *4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . . . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
Gebiet von zwei Streifen	*1 2* . . .	—	2	1	2	—	1	—	1	1	1	2	7	9	Zwei Streifen 234
	(1 2) . . .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . *3* . .	4	33	2	12	2	—	35	79	17	38	60	162	222	
	1 . . *4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . . . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2 3* . .	1	—	—	—	—	—	—	1	—	—	1	1	2	
	. *(2 3)* . .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2* . *4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2* . . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *3 4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *(3 4)* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *3* . *5*	—	—	—	—	—	—	—	—	1	—	1	0	1	
	. . . *4 5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . . *(4 5)*	—	—	—	—	—	—	—	—	—	—	—	—	—	
Gebiet von drei Streifen	*1 2 3* . .	80	140	93	53	52	80	207	181	102	135	534	589	1123	Drei Streifen 1241
	(1 2) 3 . .	6	1	6	—	6	2	56	11	18	10	92	24	116	
	1 (2 3) . .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3) . .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 . *4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) . *4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 . . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) . . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . *3 4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . *(3 4)* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . *3* . *5*	—	—	1	—	—	—	—	—	—	—	1	—	1	
	1 . . *4 5*	—	—	—	—	—	—	—	—	—	1	—	1	1	
	1 . . *(4 5)*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2 3 4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *(2 3) 4* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2 (3 4)* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *(2 3 4)* .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2 3* . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *(2 3)* . *5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2* . *4 5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. *2* . *(4 5)*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *3 4 5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *(3 4) 5*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *3 (4 5)*	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. . *(3 4 5)*	—	—	—	—	—	—	—	—	—	—	—	—	—	

TABELLE B—*Fortsetzung.*

	Lage der Streifen resp. Bänder	Fundorte										Summe			
		I		II		III		IV		V					
		a	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a*	*j*	*a+j*	
Gebiet von vier Streifen	*1 2 3 4* .	5	9	1	2	3	3	—	1	—	—	9	15	24	Vier Streifen 51
	(1 2) 3 4 .	—	—	—	—	—	—	—	—	1	—	1	—	1	
	1 (2 3) 4 .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 (3 4).	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3) 4 .	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 (2 3 4).	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) (3 4).	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3 4).	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 3 . 5	—	—	—	4	1	2	7	2	2	3	10	11	21	
	(1 2) 3 . 5	—	—	—	—	—	—	—	—	1	—	1	—	1	
	1 (2 3) . 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3) . 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 . 4 5	—	—	—	—	3	1	—	—	—	—	3	1	4	
	(1 2) . 4 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 . (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) . (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . 3 4 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . (3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . 3 (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 . (3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. 2 3 4 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. (2 3) 4 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. 2 (3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. 2 3 (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. (2 3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. 2 (3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. (2 3) (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	. (2 3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
Gebiet von fünf Streifen	*1 2 3 4 5*	35	30	16	14	174	159	31	33	19	17	275	253	528	Fünf Streifen 586
	(1 2) 3 4 5	4	—	1	1	17	3	—	—	1	1	23	5	28	
	1 (2 3) 4 5	—	—	—	—	1	—	—	—	—	—	1	—	1	
	1 2 (3 4) 5	—	—	—	—	4	6	—	—	—	—	4	6	10	
	1 2 3 (4 5)	—	—	—	—	12	1	—	—	—	—	12	1	13	
	(1 2) (3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) 3 (4 5)	—	—	—	—	3	1	—	—	—	—	3	1	4	
	1 (2 3) (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3) 4 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 (2 3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 2 (3 4 5)	—	—	—	—	—	2	—	—	—	—	—	2	2	
	(1 2 3 4) 5	—	—	—	—	—	—	—	—	—	—	—	—	—	
	1 (2 3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3) (4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2) (3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	(1 2 3 4 5)	—	—	—	—	—	—	—	—	—	—	—	—	—	
	Summe	488	809	296	249	459	471	664	841	371	493	2278	2863	5141	

Gestatten die an den einzelnen Fundorten gesammelten Thiere eine Vergleichung der Streifenformen in ihren Vertheilungsverhältnissen zu einander innerhalb eines jeden Fundgebietes, so ist bei einer Vergleichung verschiedener Fundorte stets auch zu berücksichtigen, dass hier die einzelnen Fundmengen wesentlich eine Vergleichung der Streifenformen in den Zahlenwerthen und somit auch in den hiernach construirten Curven beeinflussen können. Um daher die Werthe der verschiedenen Fundorte vergleichsfähig zu machen, ist eine Umrechnung aller Werthe auf eine für alle Funde gemeinsame gleiche Gesammtmenge S erforderlich.

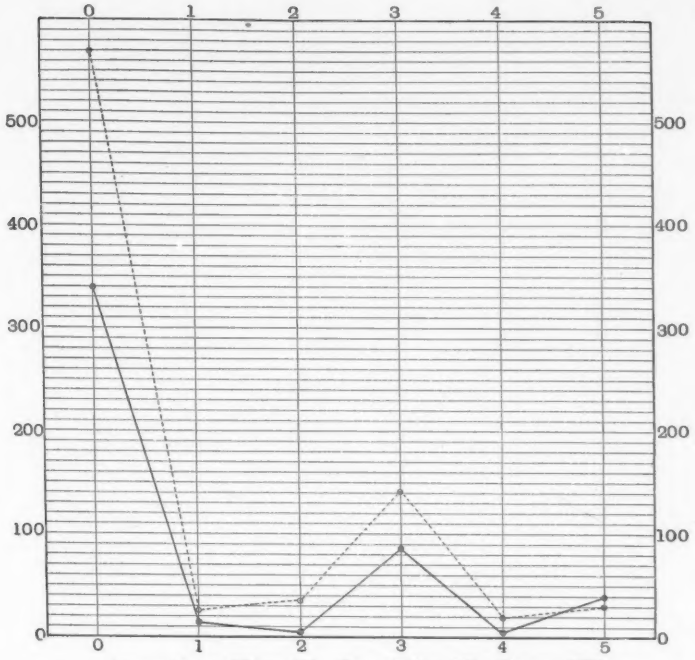
Bei solcher Umrechnung müssen die ausgewachsenen und die jungen Thiere natürlich getrennt betrachtet werden; in Tabelle A, II sind für $S = 100$ ausgewachsene resp. junge Individuen von jedem Fundort die Vergleichswerthe zusammengestellt.

Es ist deutlich ersichtlich wie bei den zusammengefassten Werthen von I, II, IV u. V die Annäherung der Werthe aneinander beträchtlich zugenommen hat. Ich habe es für wichtig gehalten hier auf die verschiedenen Arten der Vergleichung und die verschiedene Interpretation solcher Sammelwerthe besonders aufmerksam zu machen, weil sie manches lehrreiche für künftige Arbeiten in dieser Richtung enthalten dürften. Hier haben wir es bei den Pulmonaten in Folge der geringen Locomotion mit einem Untersuchungsmaterial zu thun, von dem sich auf verhältnissmässig kleinem Raum (also bei gleichen Lebensbedingungen) leicht grössere Mengen bei einiger Sorgfalt sammeln lassen, da das einmal gefundene Object sich nicht durch die Flucht zu entziehen vermag, wodurch das Werthverhältniss der Funde unter einander für die späteren vergleichenden Untersuchungen gesteigert wird.

Ist also einerseits eine gewisse Vorsicht geboten Schlussfolgerungen auf Grund der Vergleichungen der Spielarten innerhalb eines Fundortes sowie auf Grund der Werthe verschiedener Fundorte zu ziehen, so können sich andererseits auch wieder eine Reihe Regelmässigkeiten ergeben, die eine gemeinschaftliche Vergleichung erlauben und sich gewissermassen gegenseitig controlliren. Ersichtlich ist aber auch (wie die Wahrscheinlichkeit der Schlussfolgerungen ja allgemein mit der Menge der Funde zunimmt), dass immerhin ein hinreichendes Material vorhanden sein muss.

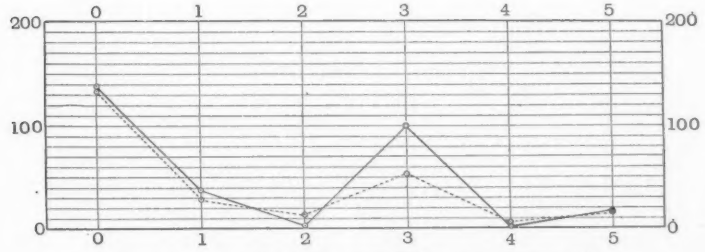
Ich hoffe noch Gelegenheit zu haben in einer späteren Mittheilung über andere Funde gerade diesen Punkt und dessen Einfluss auf die Menge der gefundenen sogenannten seltenen Varietäten näher beleuchten zu können.

Aus den hier vorliegenden Untersuchungen ergiebt sich jedenfalls aber auch, wie diese eine schätzenswerthe Unterlage für Züchtungen bilden können und Fragen hervorrufen, welche Biologie und vergleichende Anatomie zusammen zu beantworten haben werden und wie derartige Sammlungen bei Berücksichtigung aller gegebenen Bedingungen an den Fundorten, aus ihren Zahlenwerthen Hinweise ergeben können, nach welcher Richtung hin weitere Untersuchungen besonders wünschenswerth erscheinen.



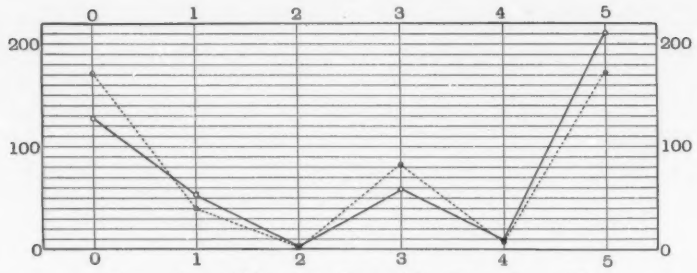
Ausgewachsene Thiere 488. Junge Thiere 809. Summe 1297.

FIG. 5. Fundort I. Werk 59. Siehe Karte S. 475. Junge Thiere - - - - - Ausgewachsene ——



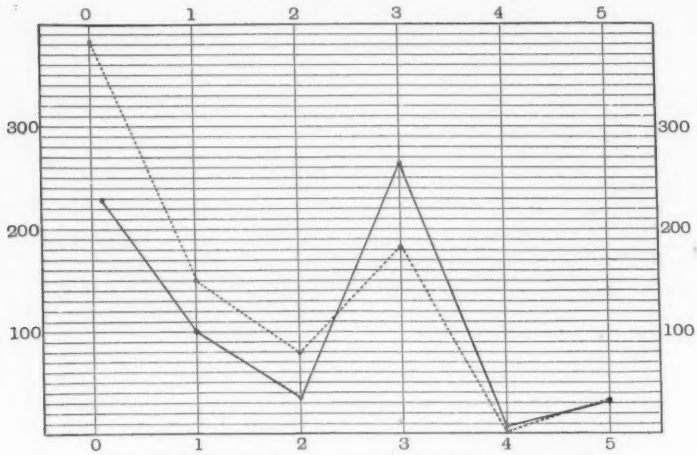
Ausgewachsene Thiere 296. Junge Thiere 249. Summe 545.

Fig. 6. Fundorte II. Werke 61 u. 62. Siehe Karte S. 475. Junge Thiere - - - - - Ausgewachsene ——



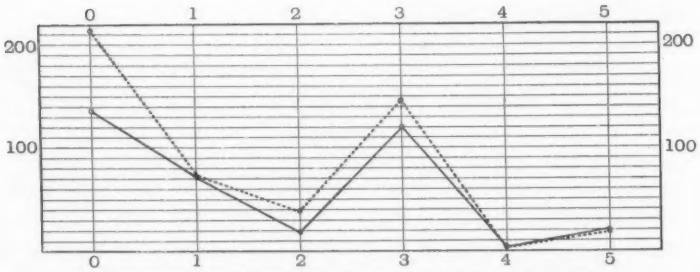
Ausgewachsene Thiere 459. Junge Thiere 471. Summe 930.

Fig. 7. Fundort III. Garten mit Gelände. Siehe Karte S. 475. Junge Thiere - - - - - Ausgewachsene ———



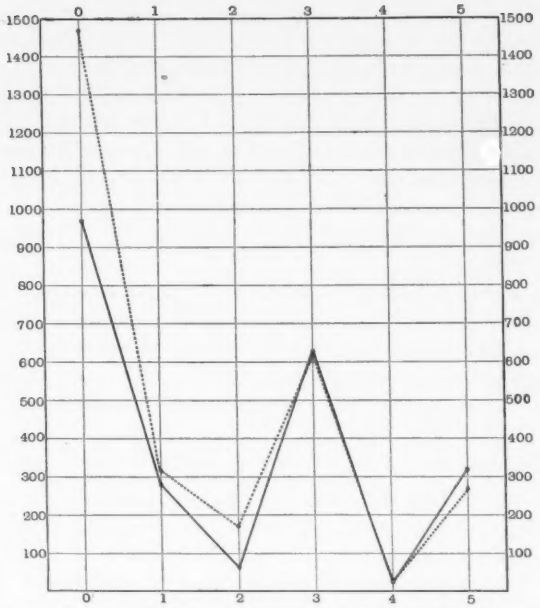
Ausgewachsene Thiere 664. Junge Thiere 841. Summe 1505.

Fig. 8. Fundorte IV. Siehe Karte S. 475. Werke 63, 64 u. 68.



Ausgewachsene Thiere 371. Junge Thiere 493. Summe 864.

Fig. 9. Fundorte V. Siehe Karte S. 475. Werke 65, 66 u. 67.



Ausgewachsene Thiere 2278. Junge Thiere 2863. Summe 5141.

FIG. 10. Funde von I bis V zusammen.

Wir haben bisher, die allgemeine Vertheilung der Varietäten nach der Anzahl betheiligter Streifen untersucht und darauf die Vergleichswerthe basirt. Welche Gebiete der Farbdrüsen dabei dominiren ist daraus nicht scharf ersichtlich. Bei diesen Sammlungen wurde aber zugleich Rücksicht genommen auf die gesonderte Zählung sämmtlicher vorkommenden Varietäten und dabei zugleich die Vollkommenheit der Entwicklung der Streifung mit in den Kreis der Beobachtung eingeschlossen. Diese Beobachtungen sind hier in der nachfolgenden Tabelle B, der eigentlichen Haupttabelle, zusammengestellt.

Die Zahlen dieser Tabelle zeigen einen ganz besonders interessanten und characteristischen Verlauf. Auch hier kommen, wie in den früheren Zahlen der Tabelle A, und in den Curven der Fig. 1—10, die beobachteten Maxima deutlich wieder zum Ausdruck in den betreffenden Streifengebieten, wir sehen aber zugleich, wie an den Gesammtmengen verhältnissmässig nur wenig Formen (von den 89 theoretisch möglichen) sich betheiligen, und wie die Formen, aus dem Gebiete der drei Streifen 1, 2, 3 sowie im Gebiete der fünf Streifen diese einzige mit einigen Nebenformen *das ganze* Gebiet der Variationen beherrschen, so dass jetzt schon gewisse Fragen und Erklärungen herausgefordert werden, welche spätere experimentelle Untersuchungen auf Werth und Berechtigung zu prüfen hätten. Hierbei dürfen wir aber das Folgende nicht ausser Acht lassen.

Bei der Untersuchung der Varietäten ist von der bekannten Bezeichnung der Reihenfolge der Streifen ausgegangen und hierauf sind die Berechnungen basirt, da von einer bestimmten Ordnung ja doch auszugehen ist. Auch für künftige Untersuchungen wird es sich empfehlen dies beizubehalten, auch schon mit Rücksicht auf die frühere Litteratur hierüber. Indessen muss bei allen derartigen Arbeiten niemals vergessen werden, dass hier lediglich ein Hülfsmittel für die Untersuchung vorliegt *und der Weg den die Natur zur Bildung und Vervollkommenung von Varietäten einschlägt nicht der gleiche zu sein braucht*, d. h. der Weg vom Einfachen zum Vollkommenen ja nicht an die Reihenfolge 1, 2, 3... u. s. w. gebunden ist.

Dies vorausgeschickt, wird auch die Bedeutung der Generaltabelle B klarer ersichtlich werden, wenn wir die Betheiligung der einzelnen Streifen in den beobachteten Varietäten feststellen, was in der nachfolgenden Tabelle C, I, zum Ausdruck kommt, aus welcher die Betheiligung der Zahl nach ersichtlich ist, und die Reihenfolge der Streifen resp. der Lagegebiete der Farbdrüsen ergiebt:

Streifen	3.	1.	2.	4.	5.
Vorkommen	2699	2119	1899	626	625

Da selbstverständlich ein Streifengebiet mehreren Varietäten gemeinschaftlich ist, so haben wir auch zugleich das Vorkommen der einzelnen Varietäten nach Zahl zu prüfen und erhalten dann die Werthe der Tabelle C, II, in welcher einmal I, II, IV u. V zusammengefasst sind (nach früherer Begründung) und auch alle Funde I—V zusammen.

TABELLE C, I.

Betheiligung der einzelnen Streifen.

Beobachtete Varietäten	Keine Farbenausscheidung	Streif 1	Streif 2	Streif 3	Streif 4	Streif 5
0	2436	—	—	—	—	—
. 2 . . .	—	—	2	—	—	—
. . 3 . .	—	—	—	591	—	—
1 2 . . .	—	9	9	—	—	—
1 . 3 . .	—	222	—	222	—	—
. 2 3 . .	—	—	2	2	—	—
. . 3 . 5	—	—	—	1	—	1
1 2 3 . .	—	1123	1123	1123	—	—
1 . 3 . 5	—	1	—	1	—	1
1 . . 4 5	—	1	—	—	1	1
(1 2) 3 . .	—	116	116	116	—	—
1 2 3 4 .	—	24	24	24	24	—
1 2 3 . 5	—	21	21	21	—	21
1 2 . 4 5	—	4	4	—	4	4
(1 2) 3 4 .	—	1	1	1	1	—
(1 2) 3 . 5	—	1	1	1	—	1
1 2 3 4 5	—	528	528	528	528	528
(1 2) 3 4 5	—	28	28	28	28	28
1 (2 3) 4 5	—	1	1	1	1	1
1 2 (3 4) 5	—	10	10	10	10	10
1 2 3 (4 5)	—	13	13	13	13	13
(1 2) 3 (4 5)	—	14	14	14	14	14
1 2 (3 4 5)	—	2	2	2	2	2
Summe	2436	2119	1899	2699	626	625

TABELLE C, II.

Betheiligung der Varietätenformen.

Beobachtete Formen	Funde von I, II, IV, V alt u. jung zusammen		Funde von III alt u. jung zusammen		Funde I—V zusammen
0	2138		298		2436
. 2 . . .	2		—		2
. . 3 . .	498		93		591
1 2 . . .	8		1		9
1 . 3 . .	220		2		222
. 2 3 . .	2		—		2
. . 3 . 5	1		—		1
1 2 3 . .	991	1099	132	140	1239
(1 2) 3 . .	108		8		
1 . 3 . 5	1		—		1
1 . . 4 5	1		—		1
1 2 3 4 .	18	19	6	6	25
(1 2) 3 4 .	1		—		
1 2 3 . 5	18	19	3	3	22
(1 2) 3 . 5	1		—		
1 2 . 4 5	—		4		4
1 2 3 4 5	195	203	333	383	586
(1 2) 3 4 5	8		20		
1 (2 3) 4 5	—		1		
1 2 (3 4) 5	—		10		
1 2 3 (4 5)	—		13		
(1 2) 3 (4 5)	—		4		
1 2 (3 4 5)	—		2		

Aus diesen Zusammenstellungen ergiebt sich, wenn wir die in der Hauptsache in Frage kommenden 5 Spielarten (einschliesslich ihrer Verschmelzungsformen) vergleichen, das folgende proportionale Verhältniss:

	a.—Für die aus I, II, IV u. V zusammengezogenen Werthe		*b.*—Für die aus I—V zusammengezogenen Werthe	
Streifenform	Beobachtete Menge	Proportionales Verhältniss	Beobachtete Menge	Proportionales Verhältniss
0	2138	10·53	2436	10·97
. . 3 . .	341	1·68	591	2·66
1 . 3 . .	220	1·08	222	1·00
1 2 3 . .	1099	4·09	1239	5·58
1 2 3 4 5	203	1·00	586	2·63

und die Reihenfolge nach Fundmengen stellt sich hiernach in das Verhältniss

Für *a*		Für *b*	
Form *0*	— 10·53	Form *0*	— 10·97
1 2 3 . .	— 4·09	*1 2 3 . .*	— 5·58
. . 3 . .	— 1·68	*. . 3 . .*	— 2·66
1 . 3 . .	— 1·08	*1 2 3 4 5*	— 2·63
1 2 3 4 5	— 1·00	*1 . 3 . .*	— 1·00

Durch derartige Eingrenzung lässt sich feststellen wo die Ausgangspunkte der Varietätenbildung zu suchen sind und welcher Werth gewissen Streifengebieten in Bezug auf die Bildung der nächstwerwandten Varietäten zukommt. Die einfache Beobachtung einer sogenannten seltenen Varietät beweist noch nicht ob man es mit einem seltenen Zwischenglied zwischen den anschliessenden Formen, mit einem Rückschlag, oder mit einer Neubildung zu thun hat. Nach den Bewerthungen der Fundresultate, wie sie hier in verschiedener Richtung durchgeführt wurden ergiebt sich, dass das Ausgangsgebiet aller Streifenbildungen im Gebiete des Streifens 3 zu suchen ist. Nach dieser Richtung hin sind spätere weitere Sammlungen mit zu untersuchen und zwar wird dann dieses Streifengebiet auch bei Sammlungen der übrigen Arten der Stylommatophoren vorherrschen müssen.

In den über 5000 Exemplare umfassenden Sammlungen nach der Gesammtübersicht (vide Tabelle B) haben sich nur die folgenden Spielarten gefunden:

1. *Streifenformen*

0	1 2 . . .	1 2 3 . .	1 2 3 4 .	1 2 3 4 5
. 2 . . .	1 . 3 . .	1 . 3 . 5	1 2 3 . 5	
. . 3 . .	. 2 3 . .	1 . . 4 5	1 2 . 4 5	
	. . 3 . 5			

Summa 14.

2. *Bänderformen keine.*

3. *Streifenformen mit Bänderformen*

(1 2) 3 . .	(1 2) 3 4 .	(1 2) 3 4 5
	(1 2) 3 . 5	1 (2 3) 4 5
		1 2 (3 4) 5
		1 2 3 (4 5)
		(1 2) 3 (4 5)
		1 2 (3 4 5)

Summa 9.

Oder total, einschliesslich der streifenlosen Form, 23.

Nach brieflicher Mittheilung wurden früher von A. Schmidt* während seiner langjährigen Untersuchungen die folgenden Spielarten beobachtet:

An Streifenformen 22

0	1 2 . . .	1 2 3 . .	1 2 3 4 .	1 2 3 4 5
1	1 . . . 5	1 2 . 4 .	1 2 3 . 5	
. 2 . . .	. 2 3 . .	1 2 . . 5	1 2 . 4 5	
. . 3 . .	. . 3 4 .	1 . 3 4 .	1 . 3 4 5	
. . . 4 .		1 . 3 . 5		
. . . . 5	. . 3 . 5	. 2 3 4 .		

* Schreiben von 25. XI. 78. Vide auch: Ad. Schmidt, *Beiträge zur Malakozoologie*, Berlin 1857; sowie Hall, *Zeitschr. der gesammten Naturwissensch.* Bd. VIII.

An Bänderformen 9

(1 2) . . .	(1 2 3) . .	(1 2)(3 4) .	(1 2)(3 4 5)
. (2 3) . .		(1 2 3 4) .	(1 2 3) (4 5)
. . (3 4) .		(1 2) . (4 5)	

An Streifen mit Bänderformen 17

(1 2) 3 . .	1 2 (3 4) .	(1 2) 3 4 5	(1 2 3) 4 5	(1 2 3 4) 5
(1 2) . 4 .	(1 2) 3 4 .	1 (2 3) 4 5	1 (2 3 4) 5	1 (2 3 4 5)
. 2 (3 4) .	(1 2) 3 . 5	1 2 (3 4) 5	1 2 (3 4 5)	
. . 3 (4 5)	(1 2) . 4 5	1 2 3 (4 5)		

Zugleich erwähnte Schmidt den Fund von einem 6-streifigen Bande. Letzterer Fund ist sicher auf eine Theilung einer der fünf Streifen zurückzuführen. Jedenfalls wird es gewagt sein alle derartige Spaltungen als neue Varietäten anzusprechen. Wir wissen das bei *H. pisana* diese Spaltung der Streifen ganz allgemein vorkommt*. Ehe hier nicht über die Lage der Drüsen und deren anatomischen Bau näheres vorliegt, sollte man um Verwirrungen vorzubeugen sich zur Zeit auf die 5 Lagegebiete beschränken.

Neben den seltenen Zwischenformen zwischen den Gruppen der Hauptformen der Sammlungen ist auch das unvollkommene Auftreten der Eigenschaften der Varietäten nicht unberücksichtigt zu lassen, denn hier müssen bei grösseren Sammlungen sowie bei der Vergleichung des Materials verschiedener Sammlungen an gleichem Fundorte aber aus verschiedenen Zeitperioden, sowie beim Vergleichen der Funde auseinanderliegender Fundorte aus der Vertheilung und Art dieser unvollkommenen Varietätenformen gewisse Schlussfolgerungen möglich werden inwieweit wir es dabei mit einem Vorwärtsschreiten oder einem Rückschritt in der Varietätenbildung zu thun haben. Die Zusammenstellung der Tabelle D enthält hier alle derartigen bei sämmtlichen fünf Fundorten beobachteten unvollkommen ausgebildeten Formen. Da hier eine Anzahl Streifenformen erst in der letzten Windung sowie am Saum auftreten, wird auch hier das Verhältniss bei ausgewachsenen und jungen Thieren schon ein ungleiches sein müssen und ein Urtheil darüber, wie sich die jungen Thiere weiter entwickelt haben würden ist natürlich vorläufig ausgeschlossen. Auch hier kann der Züchtungsversuch manches Resultat erzielen, das in der freien Natur schwerlich zu erhalten ist. Zugleich ist in der Zusammenstellung weiter noch angegeben, welche Varietäten eine *rothe* Grundfarbe des Gehäuses besassen (alle übrigen variirten von hellgelb bis tief citronengelb).

Auch bei diesen beobachteten unvollkommenen Formen sehen wir, wie die Fundmengen auch bei den Hauptformen ein Maximum zeigen. Welche Deutung ist hier nun zulässig? Sind diese unvollkommenen Formen ein Beweis für das Vorwärtsschreiten in der Bildung vollkommener Streifenformen bei 1.2.3 und in der Richtung nach 1.2.3.4.5, oder sind hier Rückgänge, Verkümmerungen

* Auch *H. pomatia* zeigt ja vielfach eine Auflösung der breiten Streifen in eine öft grosse Anzahl feiner Linien.

TABELLE D, I. *Beobachtete Varietäten der fünf Sammlungen die unvollkommen entwickelte Streifenformen aufwiesen und deren Vertheilung auf die fünf Fundorte.*

	. 2 . . .	. . 3 . .	1 2 . . .	1 . 3 . .	. 2 3 . .	. . 3 . 5	1 2 3 . .	(1 2) 3	1 . . 4 5	1 2 3 4 .	(1 2) 3 4 .	1 2 3 . 5	1 2 3 4 5	Vertheilung auf die einzelne Fundorte
I *a*	——	. .			2 schw. 1		kleiner Streif am Saum ... ... 4 l. W. ... ... 5 ½ l. W. ... ... 8 nur l. W. ... 13 *1* nur in f. L. am Saum ... ... 1 *1* in *2* f. L. ... 1			*1* schw. 1 *3* schw. 3			*4* schw. 8 *5* schw. 5 *4* u. *5* schw. 3	53
I *j*	in *2* f. L. 1	schw. 23	schw. 1	*1* schw. 12 *1* u. *3* schw. 1			sehr wache angedeutet ... 8 nur kleine Striche am Saum ... 13 ¼ l. W. ... 24 l. W. ... ... 25 mehr als eine W. 20 schw. ... ... 1 *2* u. *3* schw. ... 1			*4* schw. 6 *3* u. *4* schw. 1			*4* schw. 7 *5* schw. 1	145
II *a*			*2* schw. 1	*1* schw. 2			*1, 2* schw. ... 1 *1, 2, 3* schw. ... 63 *3* schw. ... ... 2 *2, 3* schw. ... 1 *1, 2, 3* in f. L. 1						*4* schw. 4 *5* schw. 2 *4, 5* schw. 2	79
II *j*			*2* schw. 2				*2* schw. ... ... 36 *3* schw. ... ... 1 *1, 2, 3* schw. ... 1			*3, 4* schw. 1		*3* u. *5* zz. 1	*4* schw. 3 *5* schw. 1 *4* u. *5* schw. 3	49
III *a*				*3* schw. 1			*2* schw. ... ... 5 *1* u. *2* schw. ... 2 *1, 2,* u. *3* schw. 1			*4* schw. 2 *1, 2, 4* schw. 1		*1–5* schw. 1	*4* schw. 2 *5* schw. 2 *4, 5* schw. 7 alle schw. 5	29
III *j*							*2* schw. ... ... 34 *3* schw. ... ... 2 *1, 2* schw. ... 7			*1, 2, 4* schw. 2 *4* schw. 1			*3* schw. 1 *4* schw. 5 *5* schw. 6 *4, 5* schw. 13 *2, 3, 4, 5* schw. 3 alle schw. 5	79
IV *a*				*3* schw. 5			*1* schw. ... ... 1 *2* schw. ... ... 5 *3* schw. ... ... 1 *1, 2, 3* schw. ... 1	*1* schw. 2 *3* schw. 1				*5* schw. 1	*4* schw. 4 *5* schw. 2 *4, 5* schw. 5	31
IV *j*				*1* schw. 1 *1, 3* schw. 1			*2* schw. ... ... 1 *1, 2* schw. ... 3 *2, 3* schw. ... 3	*1, 2* schw. 3				*5* schw. 2	*4* schw. 3 *4, 5* schw. 4	21
V *a*			*2* schw. 1	*3* schw. 1		*5* schw. 1	*1, 2* schw. ... 1 *2* schw. ... ... 5 *3* schw. 1	*1, 2* schw. (l. W.) 2			*3, 4* schw. 1	*1, 2, 3, 5* schw. } 1	*4* schw. 3 *5* schw. 6 *4, 5* schw. 5	29
V *j*			*1, 2* schw. 1	*1* schw. 11 *1* schw. a. l. W. 1			*1, 2* schw. ... 5 *2* schw. ... ... 15 davon *2* in *2* Streifen getheilt *3* schw. 1	*1, 2* schw. 1	*5* schw. in *3* f. L. 1			*5* schw. 3	*4* schw. 4 *5* schw. 2 *4, 5* schw. 4	49
Summe	1	23	6	36	1	1	325	9	1	18	1	9	133	564

f. L. = feinen Linien; l. = letzte; W. = Windung; zz. = zweizeilig; schw. = schwach.

in den Farbdrüsen die Ursache? Für beide Deutungen liessen sich vielleicht plausible Erklärungen erbringen, beweiskräftig für das eine oder andere werden nur zahlreiche Sammlungen und die experimentelle Untersuchung der Bedingungen der Varietätenbildung sein können.

Bei vorstehenden Betrachtungen der Fundergebnisse mag vielleicht noch mancherlei unberücksichtigt geblieben sein, was sowohl bei der Sammlung der Varietäten wie der nachherigen Untersuchung der Beachtung werth erscheinen möchte. Hier kann, nachdem in der "Biometrika" ein Organ geschaffen ist, welches an geeigneter Stelle einen Austausch von Ansichten und Wünschen gestattet, solches nur fördernd für die biologische Forschung sein und wird dies dann späteren Untersuchungen zu Gute kommen. Es werden sich dann aus dem zusammengetragenen Material Normen ausarbeiten und Grundsätze festlegen lassen, welche die wichtigsten Untersuchungsbedingungen und Hinweise enthalten die bei Sammlungen und der Verarbeitung des Materials im Auge zu behalten sind. Was z. B. für die Flora in Bezug auf den Einfluss solarer Wärme, der Feuchtigkeit und Insolation Gültigkeit besitzt und bei der Deutung des eigenartigen Verlaufes der Vegetationslinien* nicht vernachlässigt werden darf, muss

TABELLE D, II.

Verhältniss zwischen ausgebildeten und unvollkommenen Varietätenformen.

	I	II	III	IV	V
Gesammtfunde	1297	545	930	1505	864
Darunter streifenlose Formen ...	908	271	298	610	349
Bleiben Streifenformen	389	274	632	895	515
Darunter unvollkommen ausgebildet	198	128	108	52	78
Bleiben wirklich ausgebildete ...	191	146	524	843	437

[Auch hier müsste für genauere Vergleichsverhältnisse natürlich Umrechnung, auf gleiche Fundmenge basirt, stattfinden.

Betreffs der Grundfarbe der Gehäuse ist zu bemerken dass rothe Grundfarben gefunden wurden bei

	I	II	III	IV	V
a	7	10	8	21	11
j	14	16	19	15	12

alle übrigen zeigten hellgelbe bis intensiv citronengelbe Farbe.]

* 1. Drude, O., *Die Anwendung physiologischer Gesetze zur Erklärung der Vegetationslinien*, Göttingen 1876. Siehe auch die daselbst citirten Quellenschriften.

2. Tschaplowitz, F., *Untersuchungen üb. d. Einwirkung der Wärme u. d. anderen Formen d. Naturkräfte auf die Vegetationserscheinungen.* 1882.

auch für die Fauna der Pulmonaten und deren Entwicklung zu Recht bestehen und neben anderen Existenzbedingungen auch das Variiren nach verschiedener Richtung hin beeinflussen. Hierauf ist namentlich dann bei der Vergleichung der Funde an verschiedenen auseinanderliegenden Fundorten Rücksicht mit zu nehmen.

Die Möglichkeit der Vergleichung der einzelnen Thierklassen und Arten aus verschiedenen weit auseinanderliegenden Zeiträumen ist selbstverständlich eine recht beschränkte, trotz der zahlreichen (auch fossilen) Funde die fortdauernd gemacht werden, wir würden sonst auf die Fragen über das Variiren und gewisse Constanz von Variationen bestimmtere Antworten geben können. Bilden gerade hier die Weichthiere eine besonders wichtige Klasse, wodurch dieselben sich als Leitfossilien ganz unentbehrlich für die Geologie machen, so ist in Bezug auf Abstammung und Entwicklung recht wenig zu erfahren, trotz der Massenfunde, weil wir es hier nur mit der Umhüllung, in den meisten Fällen sogar nur mit Pseudomorphosen derselben zu thun haben. Wenn daher Fleischmann* selbst die Stelle citiren kann: "Andererseits erhalten wir aber durch das genannte Studium dieser Schalenreste nicht den mindesten Aufschluss über die specielle innere Organisation der Thiere, welche diese äusseren Cuticular-schalen absonderten"† so ist dieser Thatsache ihre Berechtigung nicht abzusprechen.

Wenn wir uns aber bescheiden und nur so weit zurückgreifen, als uns fossile Funde bewahrt sind, welche noch die Zeichnung auf der Schale erkennen lassen, d. h. noch wirkliche Schalenreste der Untersuchung uns zugänglich machen, so müssen sich auch aus der Bestimmung und Variabilität dieser Zeichnungen Schlussfolgerungen in Bezug auf die derzeitige Entwicklung der Farbdrüsen machen lassen, und hier lassen sich doch schon recht beträchtliche Zeiträume zurückverfolgen.

Ich hoffe noch Gelegenheit zu haben über diesbezügliche Funde aus dem Mainzer Becken namentlich aus dem in geologischer Beziehung so interessanten Mosbacher Saude bei Biebrich berichten zu können.

* *Die Descendenztheorie*, Leipzig 1901.
† Häckel, E., *Systematische Phylogenie*, Bd. II. 1896.

Auf die in dieser Mittheilung nur kurz angedeutete Art der combinatorischen Berechnung möglicher Formen, getrennt nach Streifen und Bänderformen, werde ich an anderer Stelle ausführlicher zurückkommen. Ich möchte dabei zugleich zeigen wie die Zahl der theoretisch möglichen Formen eine wesentliche Beschränkung erfährt, wenn auf die organischen Verhältnisse Rücksicht genommen wird, und diejenigen Formen eliminirt werden wo eine Verschmelzung zu Bänderformen durch die natürlichen Lageverhältnisse in der Natur eine wesentliche Erschwerung erfahren muss, so dass eine Annäherung an die aus den Funden berechneten Vertheilungsverhältnisse eintreten kann.

C. H. August 26ten. 1902.

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